# TTESwitch A664 Lab v2.0

# User Manual

| | |
|---|---|
| **Document type:** | User Manual |
| **Document number:** | D-A664Lab-G-05-001 |
| **Document revision:** | 1.0.1 |
| **Document date:** | 2020-06-29 |
| **Security:** | Confidential |
| **Status:** | Released |
| **Product version:** | 2.0.0 |

**TTTech Computertechnik AG**
Schoenbrunner Str. 7, A-1040 Vienna, Austria,Tel. +43 1 585 34 34 – 0, Fax +43 1 585 34 34 – 90, office@tttech.com

# Table of Contents





Document Number:
D-A664Lab-G-05-001

# List of Tables

TTTech

# List of Figures

# Legal Disclaimer

THE INFORMATION GIVEN IN THIS USER MANUAL IS GIVEN AS A SUPPORT FOR THE USAGE OF THE TTESWITCH A664 LAB V2.0 ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE TTESWITCH A664 LAB V2.0. THE RECIPIENT OF THIS USER MANUAL MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION.

TTTECH COMPUTERTECHNIK AG PROVIDES THE USER MANUAL FOR THE TTESWITCH A664 LAB V2.0 “AS IS” AND WITH ALL FAULTS AND HEREBY DISCLAIMS ALL WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OR COMPLETENESS, OR OF RESULTS TO THE EXTENT PERMITTED BY APPLICABLE LAW. THE ENTIRE RISK, AS TO THE QUALITY, USE OR PERFORMANCE OF THE USER MANUAL, REMAINS WITH THE RECIPIENT. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW TTTECH COMPUTERTECHNIK AG SHALL IN NO EVENT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES WHATSOEVER (INCLUDING BUT NOT LIMITED TO LOSS OF DATA, DATA BEING RENDERED INACCURATE, BUSINESS INTERRUPTION OR ANY OTHER PECUNIARY OR OTHER LOSS WHATSOEVER) ARISING OUT OF THE USE OR INABILITY TO USE THE USER MANUAL, EVEN IF TTTECH COMPUTERTECHNIK AG HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

TTTECH COMPUTERTECHNIK AG MAKES NO WARRANTY OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW DISCLAIMS ALL LIABILITIES OR DAMAGES RESULTING FROM OR ARISING OUT OF THE APPLICATION OR USE OF THESE PRODUCTS.

# Limited Rights Notice (Dec 2007)

(a) THESE DATA ARE SUBMITTED WITH LIMITED RIGHTS UNDER ANY U.S. GOVERNMENT CONTRACT AND SUBCONTRACT. THESE DATA MAY BE REPRODUCED AND USED BY THE GOVERNMENT OR THE PRIME CONTRACTOR WITH THE EXPRESS LIMITATION THAT THEY WILL NOT, WITHOUT WRITTEN PERMISSION OF THE CONTRACTOR, BE USED FOR PURPOSES OF MANUFACTURE NOR DISCLOSED OUTSIDE THE GOVERNMENT.

(b) THIS NOTICE SHALL BE MARKED ON ANY REPRODUCTION OF THESE DATA, IN WHOLE OR IN PART.



**TTESwitch A664 Lab v2.0 User Manual**

Document version **1.0.1** of 2020-06-29

Document number: **D-A664Lab-G-05-001**

# 1 Introduction

The TTE-Switch A664 Lab v2.0 supports *laboratory testing* efforts of TTEthernet.

TTEthernet is a fault-tolerant real-time communication protocol for safety-related systems that makes it possible to conveniently configure the deterministic processing of *critical* Ethernet traffic (time-triggered, ARINC 664 P7 [2]) and *non-critical*, standard Ethernet traffic (IEEE 802.3 [6]) in one physical infrastructure.

### Switching function

The TTE-Switch A664 Lab v2.0 is a high-performance deterministic Ethernet switch that makes it possible to implement critical network-centric applications and process packets on all its 24 ports with full-line speeds, operating in full-duplex mode:

- 6 x triple-speed 10/100/1000 Mbit/s ports, and
- 18 x 10/100 Mbit/s ports

One additional port is available for traffic mirroring. The TTE-Switch A664 Lab v2.0 has built-in mechanisms for traffic policing and fault isolation.

### Virtual links and protocol support

The TTE-Switch A664 Lab v2.0 allows configuring up to 4096 virtual links (VLs). Virtual links can be configured with 8 priorities and a bandwidth allocation gap (BAG) of 0.01 ms to 1310.71 ms. The network configuration is stored in the non-volatile memory of the switch (256 Mbit). It is optionally possible to configure IEEE 802.1Q VLANs. Profiled IP/UDP, redundancy management, and traffic shaping are implemented in hardware.

### Data loading and diagnosis

The built-in management module runs on a separate CPU and allows for data loading and the querying of the network status via SNMP. Data loading is done according to ARINC 615A-3/TFTP and ARINC 665-loadable software parts.

# 2 Overview of the TTE-Switch A664 Lab v2.0

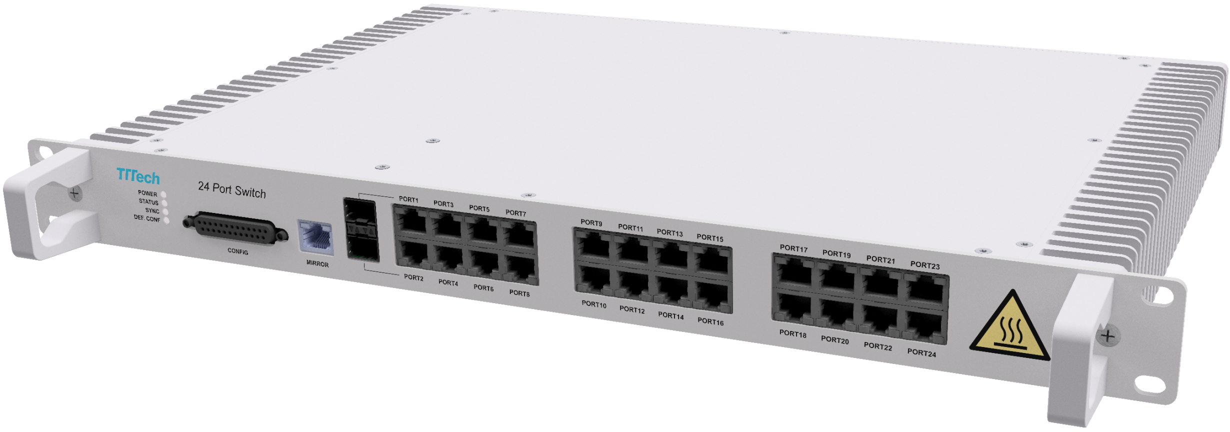



**Figure 1:** *The TTE-Switch A664 Lab v2.0*

## 2.1 Identification

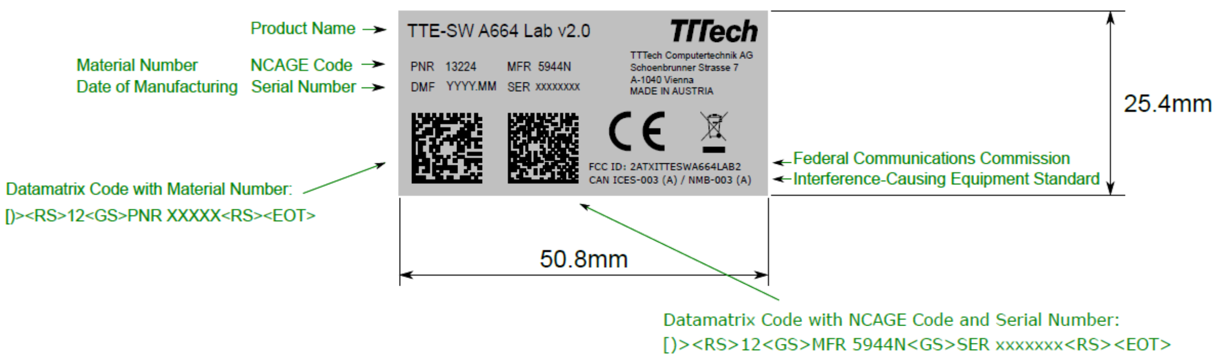



**Figure 2:** *Product identification label*

## 2.2 External interfaces

1. 4 x Status LEDs (POWER/STATUS/SYNC/DEF. CONF)
2. 1 x DB-25S configuration interface for diagnosis and maintenance and access to switch discretes
3. 1 x 10/100/1000 Mbit/s MIRROR port for mirroring
4. 2 x 10/100/1000 Mbit/s Ethernet ports (PORT1 and PORT2) that can be used either via SFP or RJ45
5. 4 x 10/100/1000 Mbit/s Ethernet ports via RJ45
6. 18 x 10/100 Mbit/s Ethernet ports via RJ45
7. 1 x Ethernet Link/Activity LED per port
8. 1 x JTAG connector for factory testing and programming
9. 1 x RS-232 serial interface that can be used for debugging
10. 1 x IEC 60320-1 C13 type power connector. The switch has an electrical fuse that protects the external power rail so that a failing switch does not cause the system power supply rail to fail.

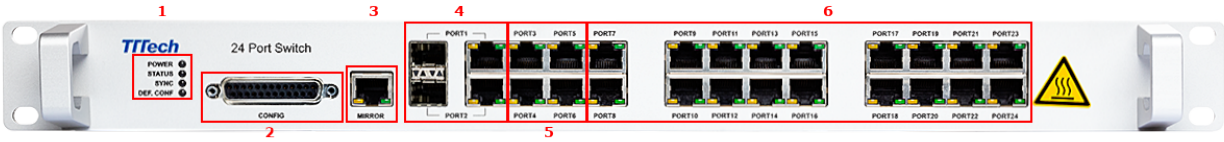



**Figure 3:** *Front view of the TTE-Switch A664 Lab v2.0*

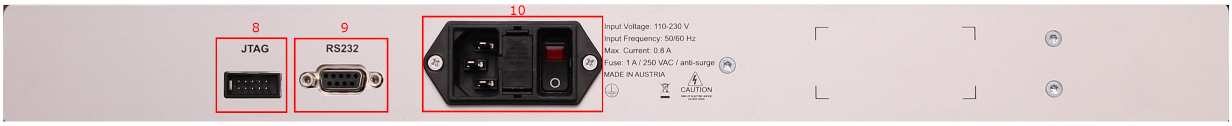



**Figure 4:** *Rear view of the TTE-Switch A664 Lab v2.0*

## 2.3 Functional features

- Full line speed switching capability
- The switch supports partitioning between three traffic classes on each port:
  a) Rate-constrained traffic (full compliance with ARINC 664 part 7 [2]),
  b) Time-triggered traffic (SAE AS 6802 [7]), and
  c) Best-effort traffic (IEEE 802.3-2005 [6])
- 32 MB of memory
- 256 Mbit Flash memory for storing switch configurations
- Application CPU for management functions
- Configuration data programmable via ARINC 615A [1]/TFTP
- Built-in self-tests (BISTs) for health monitoring
- Monitoring faulty/healthy switch state through SNMP
- Pin programming support
- External adapter with 12 dip switches for pin programming (including parity) and mode selection.

### Supported network standards

- The switch forwards best-effort traffic in compliance with IEEE 802.3-2005 [6] (switching). The switch has a maximum internal non-blocking port-to-port latency of 2 µs for 1 Gbit/s ports, 20 µs for 100 Mbit/s ports, and 200 µs for 10 Mbit/s ports. This is for a frame size of 1518 bytes, sent as best-effort (BE) traffic. The switch allows limiting best-effort traffic for each ingress and egress port.
- The switch forwards VLAN-tagged frames according to IEEE 802.1Q [4] (VLAN core capabilities).

**NOTE**

> The switch does not implement port-based VLANs (edge switch). This means that the switch cannot add VLAN tags to frames coming in on a specific port. The switch does not implement content-based VLANs (e.g., based on IP addresses or TCP/UDP ports).

The switch supports static VLAN routing according to a configuration table. VLAN frames will be accepted and routed only to the configured switch ports. VLANs are processed with a higher priority than BE frames without a VLAN tag. The switch routes VLAN frames according to the priority specified in the VLAN field. Frames with the same VLAN priority are processed on the basis of the incoming switch port number. VLAN frames with the same priority are handled in a similar way as RC frames with the same priority. Frames from Port 1 have priority over frames from Port 2. The switch can store VLAN frames in a separated buffer space. Depending on the respective configuration, BE and VLAN frames cannot share the same buffer space. Frames that contain a VLAN tag that is not in the list of the configured VLAN IDs are routed according to a default VLAN route. A default VLAN route specifies to which ports such frames can be routed. If no port is configured, these frames are dropped.

### TTEthernet implementation

- 8 sub-schedules
- 8 clock synchronization masters
- 4096 virtual links
- Store-and-forward switch architecture

### ARINC 664 p7 implementation

- Policing, filtering, switching engine for band-width control and traffic prioritizing
- Integrity checking and error checking of frames
- 4096 virtual links with up to 8 priorities, with restrictions of their associated ports
- 4096 BAGs
- BAGs freely configurable from 0.01 to 1310 ms
- BAG configuration granularity 100 µs
- Jitter and BAG resolution of 8 ns
- The switch supports ICMP (ping), SNMP v1 and A615A-3.
- Configuration data programmable via ARINC 615A/TFTP

### Physical specifications

- 19-inch rack housing, 1 height unit (1U)

### Power supply

- 110-230 V, 50/60 Hz
- 0.8 A max. current

### Environmental operating ranges

- Operating temperature: 0 °C to +70 °C

### Standards compliance

- **IEEE 802.3™**-2005 (switching, flow control) [6].
- **IEEE 802.1Q™**-2011 [4]
- **IEEE 1588-2008**: The switch supports the IEEE 1588 end-to-end transparent clock mode. The clock of the switch is not synchronized to the IEEE 1588 Master Clock [5].
- **ARINC Specification 664P7-1**: The switch is fully compliant with ARINC 664 part 7 (deterministic Ethernet networking) [2].
- **SAE AS 6802**: The switch supports the SAE AS 6802 network synchronization and start-up mechanism (fault-tolerant TTEthernet clock synchronization protocol) [7].

# 3 Functional description

This section describes the functionality of the TTE-Switch A664 Lab v2.0.

## 3.1 Block diagram

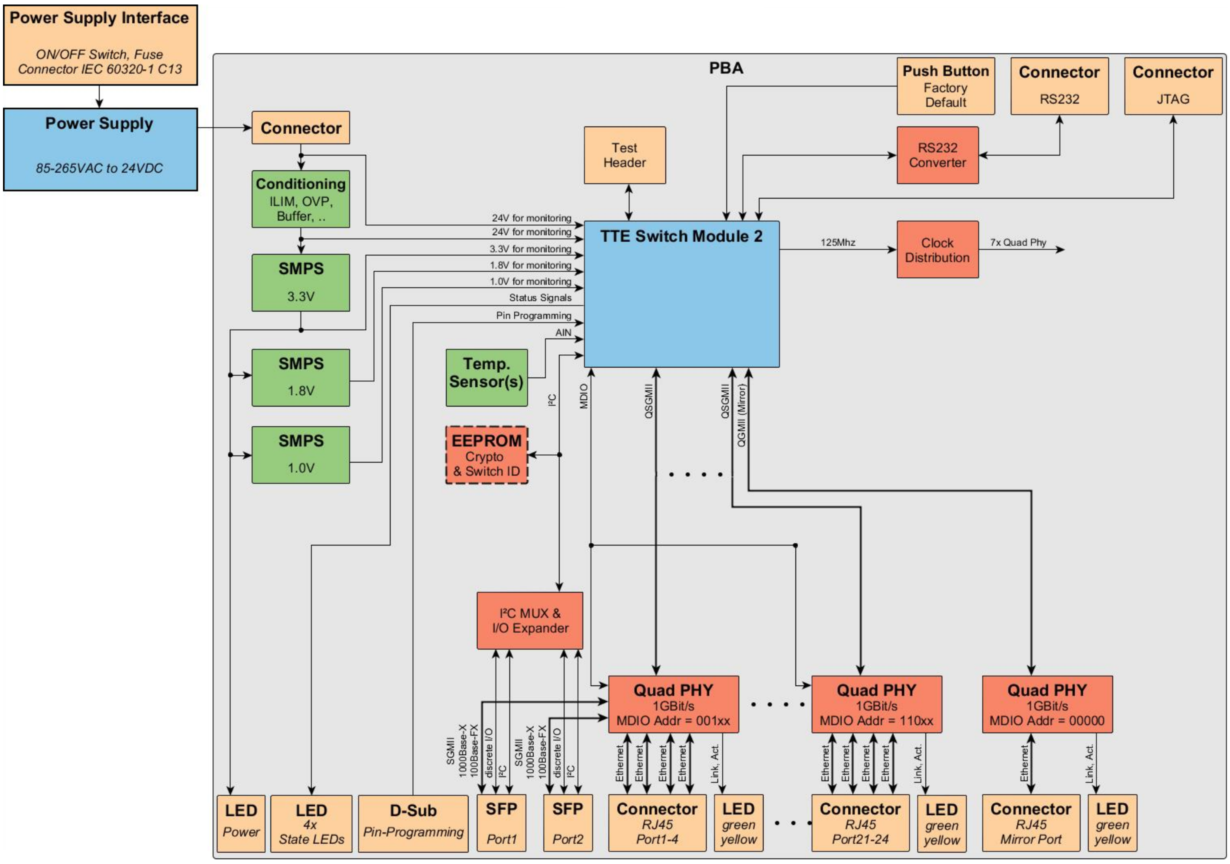



**Figure 5:** *Block diagram of the TTE-Switch A664 Lab v2.0*

### 3.1.1 Primary components

Base Board:

- 25 Ethernet transceivers (18 x 10/100 Mbit/s ports, 6 x 10/100/1000 Mbit/s ports, and 1 x 10/100/1000 Mbit/s port for mirroring only).

TTE Switch Module 2:

- ASIC as switch engine.
- Reduced-latency DRAM with a storage capacity of 288 Mbit and running at 320 MHz.
- Application CPU that controls BISTs, error logging and management functions.
- Three 256 Mbit Flash memory ICs for storing the configuration(s) (CPU Flash).
- JTAG chain that offers access to the CPU and reduced-latency DRAM for debugging, production testing and programming the flash memories.
- A 64 kbit FRAM used for error logging.

## 3.2 Interfaces

This section describes the front-panel and back-panel interfaces of the TTE-Switch A664 Lab v2.0.

### 3.2.1 Status LEDs

In operation, the front-panel LEDs of the TTE-Switch A664 Lab v2.0 indicate the following status information. An empty field in the table means the respective LED is not relevant for the given status:

| POWER | STATUS | SYNC | DEF. CONF | Description |
|---|---|---|---|---|
| ● green | | | | When the power supply of the switch is turned on, the *POWER* LED is solid green. |
| ● green | ● red | | | When the bootloader starts or when the parity check fails, the *STATUS* LED is solid red. |
| ● green | ● red (flashing) | | | When the firmware activation fails, the *STATUS* LED (controlled by the bootloader) flashes red. |
| ● green | ● orange (flashing) | | | When no valid configuration is found, the *STATUS* LED flashes orange. |
| ● green | ● green | | | When the firmware is running in Normal mode, the *STATUS* LED is solid green. |
| ● green | ● orange | | | During start-up (initializing PHYs, running PBISTs, etc) or when the firmware is running in SHOP mode, the *STATUS* LED is solid orange. |
| ● green | ● green | ● grey | | When the firmware is running without an active TTEthernet synchronization in Normal mode, the *STATUS* LED is solid green and the *SYNC* LED is off. |
| ● green | ● orange | ● grey | | When the firmware is running without an active TTEthernet synchronization in SHOP mode, the *STATUS* LED is solid orange and the *SYNC* LED is off. |
| ● green | ● green | ● green | | When the firmware is running with an active TTEthernet synchronization in Normal mode, the *STATUS* LED and the *SYNC* LED are solid green. |
| ● green | ● orange | ● green | | When the firmware is running with an active TTEthernet synchronization in SHOP mode, the *STATUS* LED is solid orange and the *SYNC* LED is solid green. |
| ● green | ● green | | ● green | When the switch has successfully started up and loaded the default configuration in Normal mode, the *STATUS* and *DEF. CONF* LEDs are solid green. |
| ● green | ● orange | | ● green | When the switch has successfully started up and loaded the default configuration in SHOP mode, the *STATUS* LED is solid orange and the *DEF. CONF* LED is solid green. |
| ● green | ● green | | ● grey | When the switch has successfully loaded the backup configuration in Normal mode, the *STATUS* is solid green and the *DEF. CONF* LED is off. |
| ● green | ● orange | | ● grey | When the switch has successfully loaded the backup configuration in SHOP mode, the *STATUS* LED is solid orange and the *DEF. CONF* LED is off. |

**Table 1:** *Front panel status LEDs of the TTE-Switch A664 Lab v2.0*

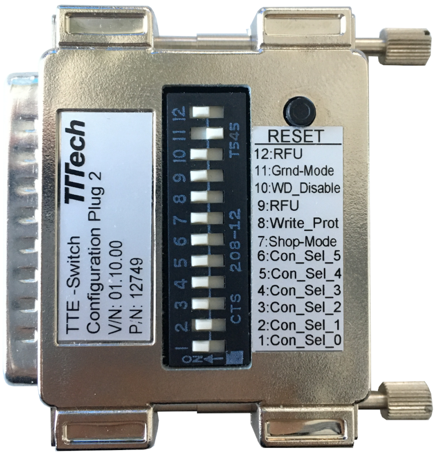


Document Number:
D-A664Lab-G-05-001

### 3.2.2 CONFIG interface and configuration plug

Connector type: 25-pin D-sub female connector (DB-25S)


**(a)** *The DB-25S CONFIG interface*




**(b)** *The DB-25P configuration plug*

**Figure 6:** *The CONFIG interface of the TTE-Switch A664 Lab v2.0*

The DB-25P configuration plug (see Figure 6b on this page) makes it possible to select configurations and operating modes of the switch.

| Pin | Pin Type | Description | Dip Switch No. | Signal Name |
|---|---|---|---|---|
| 1 | Output | Reset push button | – | RESET |
| 2 | Output | Configuration selection 0 dip switch | 1 | CON_SEL_0 |
| 3 | Output | Configuration selection 1 dip switch | 2 | CON_SEL_1 |
| 4 | Output | Configuration selection 2 dip switch | 3 | CON_SEL_2 |
| 5 | Output | Configuration selection 3 dip switch | 4 | CON_SEL_3 |
| 6 | Output | Configuration selection 4 dip switch | 5 | CON_SEL_4 |
| 7 | Output | Configuration selection 5 dip switch | 6 | CON_SEL_5 |
| 8 | Output | Reserved for future use | 9 | RFU |
| 9 | Output | Dip switch | 7 | Shop-Mode |
| 10 | NC | Not connected | – | NC |
| 11 | Output | Dip switch | 8 | Write_Prot |
| 12 | NC | Not connected | – | NC |
| 13 | NC | Not connected | – | NC |
| 14 | NC | Not connected | – | NC |
| 15 | NC | Not connected | – | NC |
| 16 | NC | Not connected | – | NC |
| 17 | NC | Not connected | – | NC |
| 18 | Output | Dip switch | 10 | WD_Disable |
| 19 | Output | Dip switch | 11 | Grnd-Mode |
| 20 | Output | Maintenance dip switch | 12 | RFU |
| 21 | NC | Not connected | – | NC |

| Pin | Pin Type | Description | Dip Switch No. | Signal Name |
|---|---|---|---|---|
| 22 | NC | Not connected | – | NC |
| 23 | Ground | Dip switch ground | – | GND |
| 24 | Ground | Dip switch ground | – | GND |
| 25 | Ground | Dip switch ground | – | GND |

**Table 2:** *Pin assignment of the Configuration Plug*

#### 3.2.2.1 Pin programming scheme

The programming pins **Con_Sel_0** (LSB) to **Con_Sel_4** (MSB) are used to represent the configuration index, whereas **Con_Sel_5** is used as the **parity bit** (even parity). See also Figure 6b on the previous page and Table 2 on this page. Depending on the selected programming pin combination, a switch configuration is loaded from one of 16 possible positions.

- If the dip switch is set to position **ON**, the pin is connected to Ground on the connector.
- If the dip switch is set to position **OFF**, the pin is not connected at all on the connector.

Table 3 on the current page lists the valid programming pin combinations that are possible for the default configuration (**Con_Sel_0** = OFF).

**NOTE** To select a programming pin combination for the actual/backup configuration, set **Con_Sel_0** to ON.

| Position | Con_Sel_0 | Con_Sel_1 | Con_Sel_2 | Con_Sel_3 | Con_Sel_4 | Con_Sel_5 |
|---|---|---|---|---|---|---|
| 0 | OFF | ON | ON | ON | ON | ON |
| 1 | OFF | OFF | ON | ON | ON | OFF |
| 2 | OFF | ON | OFF | ON | ON | OFF |
| 3 | OFF | OFF | OFF | ON | ON | ON |
| 4 | OFF | ON | ON | OFF | ON | OFF |
| 5 | OFF | OFF | ON | OFF | ON | ON |
| 6 | OFF | ON | OFF | OFF | ON | ON |
| 7 | OFF | OFF | OFF | OFF | ON | OFF |
| 8 | OFF | ON | ON | ON | OFF | OFF |
| 9 | OFF | OFF | ON | ON | OFF | ON |
| 10 | OFF | ON | OFF | ON | OFF | ON |
| 11 | OFF | OFF | OFF | ON | OFF | OFF |
| 12 | OFF | ON | ON | OFF | OFF | ON |
| 13 | OFF | OFF | ON | OFF | OFF | OFF |
| 14 | OFF | ON | OFF | OFF | OFF | OFF |
| 15 | OFF | OFF | OFF | OFF | OFF | ON |

**Table 3:** *Valid programming pin combinations for the default configuration*

**NOTE** Selecting a new programming pin combination at startup is only possible if the **Grnd-Mode** dip switch is set to **ON**, i.e. if unrestricted mode is active.

### 3.2.3 MIRROR port

The TTE-Switch A664 Lab v2.0 has a 10/100/1000 Mbit/s mirror port that can be used to forward selected traffic to a dedicated monitoring end system (e.g. a PC running Wireshark).
For monitoring, an end system must be configured in the network description, or the mirror port must be configured via the RS-232 interface. Configuring the mirror port via the RS-232 interface is only possible in SHOP mode.

**NOTE** For CLI commands to enable hardware mirroring, see Section 7.5.3 on page 33.

### 3.2.4 Ethernet ports

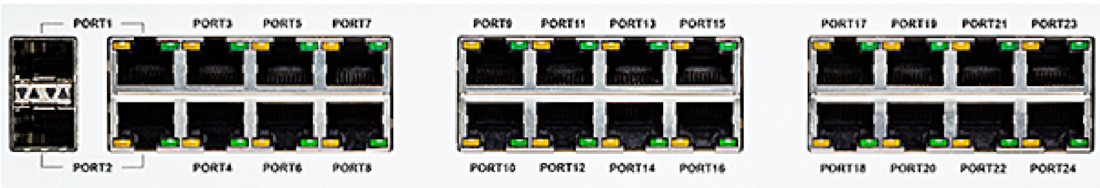



**Figure 7:** *The Ethernet ports of the TTE-Switch A664 Lab v2.0*

The switch has 24 Ethernet ports, numbered PORT1 to PORT24. Ethernet ports PORT1 and PORT2 are special as they can be used either via SFP or RJ45. For each of these two ports, only one of the connectors can be used at a time as both the SFP and RJ45 interface connect to the same physical layer. The ports are configured as follows:

| Port | Description |
|---|---|
| **1 … 2** | General-purpose SFP and RJ45 Ethernet ports:<br>fiber medium – 100Base-FX/1000Base-X<br>copper medium – 10Base-T/100Base-TX/1000Base-T |
| **3 … 6** | General-purpose RJ45 Ethernet ports:<br>copper medium – 10Base-T/100Base-TX/1000Base-T |
| **7 … 24** | General-purpose RJ45 Ethernet ports:<br>copper medium – 10Base-T/100Base-TX |

**Table 4:** *Ethernet ports of the TTE-Switch A664 Lab v2.0*

**NOTE** Hot-plugging of SFP modules (i.e. inserting a module during run-time) is not supported by the switch and requires a reset to configure the module properly.

There are two LEDs per port integrated in the connector, a green Link LED and a yellow Activity LED.

| Port LED | Description |
|---|---|
| | The Link LED is solid green when a link is established with the connected end system. |
| | The Activity LED flashes yellow when communication activity is detected (frame transmission or frame reception). |

**Table 5:** *RJ45 port LED status*

### 3.2.5 JTAG interface

The JTAG connector is used for factory testing and firmware programming.

### 3.2.6 RS-232 interface

The RS-232 interface is used for debugging in SHOP mode (see Section 5.6 on page 22). The control interface complies with the RS-232 standard and enables connection to one of the COM ports of a PC using a serial 1:1 adapter cable (DB-9 connector to DB-9 socket). The settings are 19200 baud, 8 data bits, one stop bit, no handshake, no parity.

| Pin No. | Signal Name | Signal Type |
|---|---|---|
| 1 | NC | Not connected |
| 2 | RS232_TXD_D-SUB | Transmit data output from the TTE-Switch A664 Lab v2.0 |
| 3 | RS232_RXD_D-SUB | Receive data input from the TTE-Switch A664 Lab v2.0 |
| 4 | NC | Not connected |
| 5 | GND | Ground |
| 6 | NC | Not connected |
| 7 | NC | Not connected |
| 8 | NC | Not connected |
| 9 | NC | Not connected |

**Table 6:** *Pin assignment of the RS-232 interface*

## 3.3 Technical data of the TTE-Switch A664 Lab v2.0

### 3.3.1 Cooling

The TTE-Switch A664 Lab v2.0 is constructed for passive cooling only and can withstand an operational ambient temperature ranging from 0 °C to +70 °C without air flow.

**NOTE** When the switch is used in environmental conditions with temperatures exceeding +45 °C , it is mandatory to mount the switch in a suitable rack to avoid the risk of burns or other personal injury.

### 3.3.2 Size

The dimensions of the TTE-Switch A664 Lab v2.0 are according to 1U of IEC 60297 [3]. Size (in mm): 351 x 482.6 x 43.8

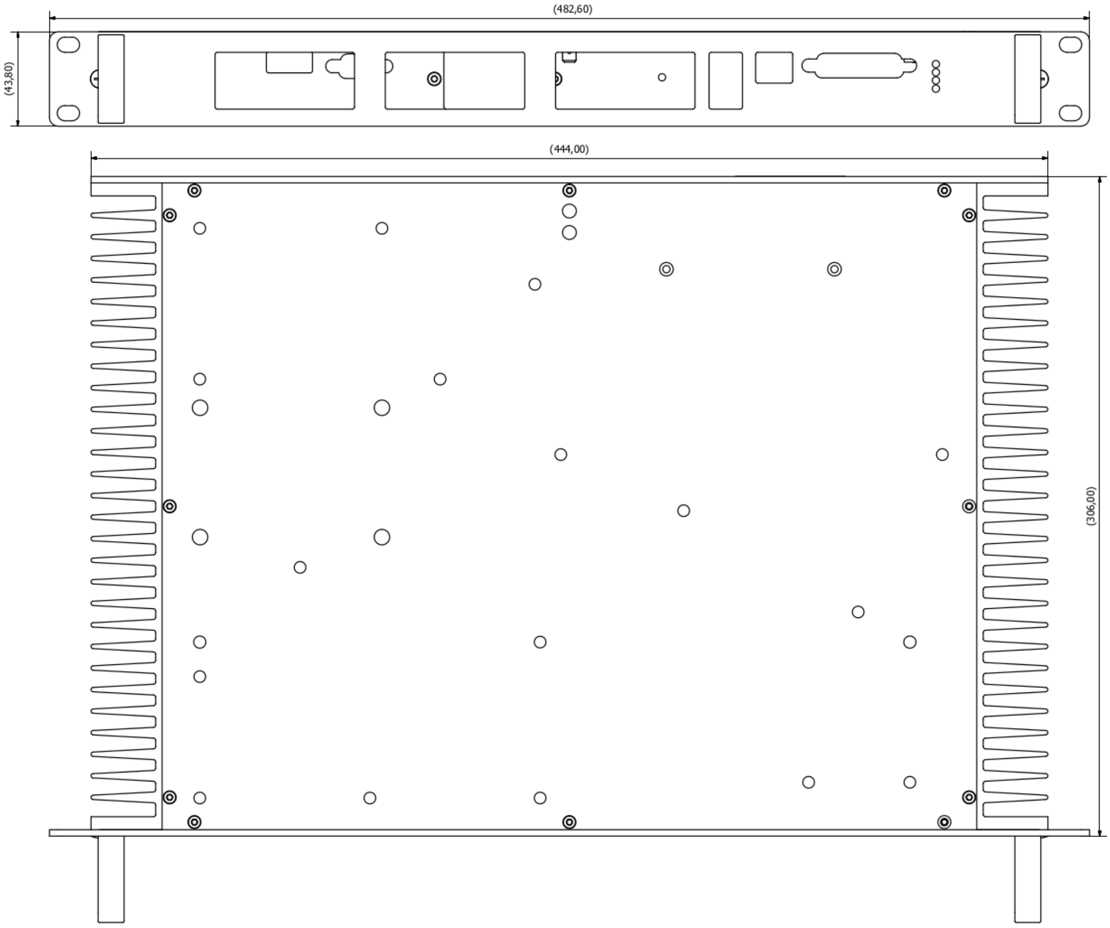



**Figure 8:** *Dimensions of the TTE-Switch A664 Lab v2.0*

### 3.3.3 Weight

The TTE-Switch A664 Lab v2.0 has a maximum weight of 5 kg.

### 3.3.4 Electrical characteristics

**Power Supply:**
The switch supports the following input voltage:

- Voltage: 85 VAC - 264 VAC
- Frequency: 47 Hz - 63 Hz

**Power Consumption:**
The switch consumes a maximum of 45 W.

**Grounding:**

- For ESD protection, Signal Ground (GND) is connected with 5 x 1 nF and 2 x 10 MΩ to CHASSISGND.
- Signal Ground (GND) is AC/DC-coupled with CHASSISGND, which is connected to the housing and the metal-plated connectors (Ethernet RJ45, SFP Cages, D-SUB DE-9, D-SUB DE-25), which can be accessed from outside.

# 4 Getting started

This section describes the sequence of steps to get started with the TTE-Switch A664 Lab v2.0.

1. Make sure the switch is connected to a power outlet and switched off.
2. Connect an RS-232 connector to the RS-232 serial interface on the back panel of the switch (see also Appendix B).
   The settings for serial communication are: 19200 baud, 8 data bits, 1 stop bit, no parity, no handshake.
3. Connect the DB-25P configuration plug to the DB-25S CONFIG interface on the front panel of the switch.
4. On the DB-25P configuration plug, use the following dip switch positions to load the default configuration of Position 0:

| Dip Switch | Position |
|---|---|
| Con_Sel_0 | OFF |
| Con_Sel_1 | ON |
| Con_Sel_2 | ON |
| Con_Sel_3 | ON |
| Con_Sel_4 | ON |
| Con_Sel_5 | ON |
| Shop-Mode | OFF |
| Maintenance | OFF |
| Grnd-Mode | ON |

5. Turn on the power switch.
   - On start-up, all status LEDs are briefly turned on, which changes during the switch start-up sequence (see Table 1 on page 11).
   - When the switch has successfully finished start-up, the POWER LED and the STATUS LED are solid green. As the switch default configuration was selected for start-up, the DEF. CONF LED is solid green as well.
   - See Appendix B for the serial terminal output during start-up.

   In the **Operational** state the switch provides information via SNMP. In **SHOP** mode, it is possible to retrieve more detailed information via serial terminal.
6. Connect a host PC directly to one of the 24 front-panel ports using a standard Cat5 or Cat5e patch cable.
   - Set the IP address of the host PC to the same subnet as the switch, for example to `10.10.10.20`.
   - Set the subnet mask of the host PC to `255.255.255.0`.
   - Set the transmission speed to `100 Mbps Full Duplex` and make sure auto-negotiation is activated.
7. To verify that the switch is operational, open the CLI window, type `ping 10.10.10.10` and press Enter. If no data packet was lost, the ping was successful.

```
Pinging 10.10.10.10 with 32 bytes of data:
Reply from 10.10.10.10: bytes=32 time=12ms TTL=128
Reply from 10.10.10.10: bytes=32 time=9ms TTL=128
Reply from 10.10.10.10: bytes=32 time=7ms TTL=128
```

```
Reply from 10.10.10.10: bytes=32 time=7ms TTL=128

Ping statistics for 10.10.10.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 7ms, Maximum = 12ms, Average = 8ms
```

# 5 State machine

Figure 9 on the current page shows the different states of the TTE-Switch A664 Lab v2.0 and the conditions for transitions between these states.

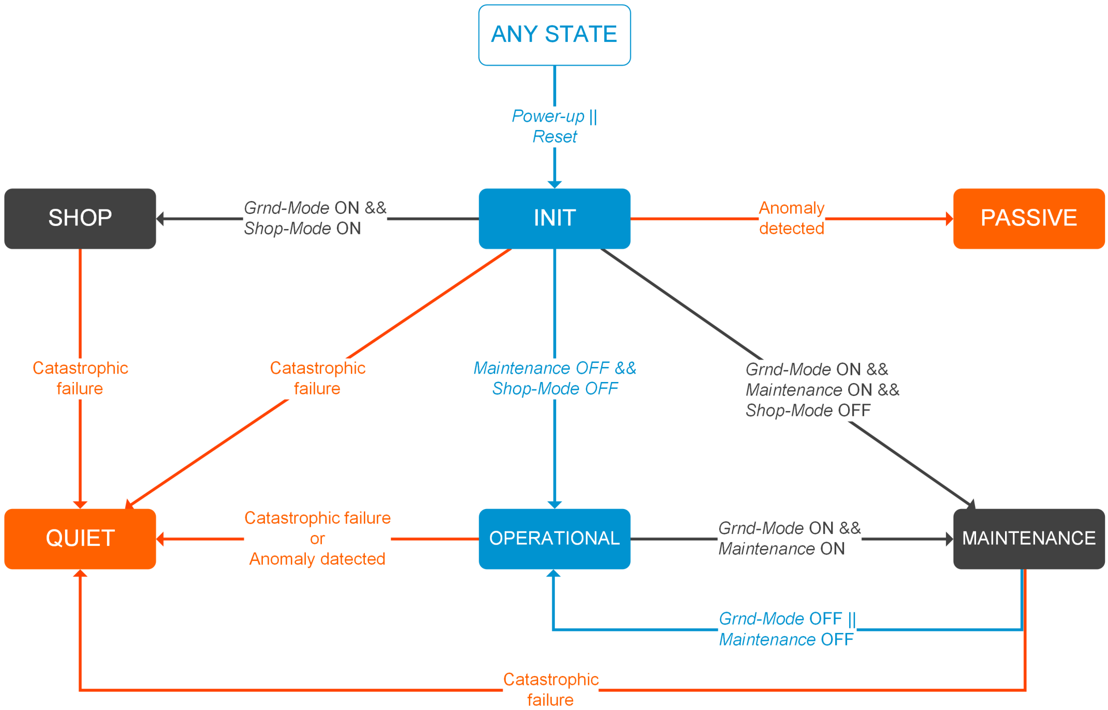



**Figure 9:** *The TTE-Switch A664 Lab v2.0 state machine*

The states of the TTE-Switch A664 Lab v2.0 correspond to the following ARINC 664P7-1 [2] specifications:

| TTE-Switch A664 Lab v2.0 | ARINC 664P7-1 |
|---|---|
| INIT | INIT |
| SHOP | SHOP |
| PASSIVE | PASSIVE |
| QUIET | QUIET |
| OPERATIONAL | OPS |
| MAINTENANCE | DL |

The various states of the TTE-Switch A664 Lab v2.0 provide the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| INIT | No | No | No | No | Abbreviated/full PBIST |
| MAINTENANCE | Yes | No | Yes | Yes | CBIST, IBIST |
| OPERATIONAL | Yes | No | No | Yes | CBIST |
| PASSIVE | No | No | No | No | No |
| QUIET | No | No | No | No | No |
| SHOP | No | Yes | No | No | CBIST |

**Table 7:** *Functionality of the various states*

**NOTE** Enabling **Grnd-Mode** via the DB-25P configuration plug puts the TTE-Switch A664 Lab v2.0 into *unrestricted* mode. Disabling **Grnd-Mode** puts the switch into *restricted* mode, by contrast.
Restricted mode disallows maintenance operations that might pose a safety hazard during non-ground operation (i.e., flight mode) for a behavior similar to a flight switch.

## 5.1 INIT

In the INIT state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| INIT | No | No | No | No | Abbreviated/full PBIST |

The TTE-Switch A664 Lab v2.0 transitions to the INIT state after a power-up or reset. In the INIT state, the switch performs an initialization sequence. The firmware initializes the peripherals of the switch for the switch IP and the end system IP. The firmware then reads out the pins on the configuration interface. If **Grnd-Mode** is **OFF**, the configuration pins will not be read from the interface. Instead, the position stored in non-volatile memory will be used.
After checking the parity of the configuration index, the availability and the CRC of the selected configuration, the switch applies the configuration.

### Transitions

Depending on the DB-25P configuration plug settings and whether errors are detected or not, several transitions from the INIT state are possible:

| Transition to | Shop-Mode | Grnd-Mode | Maintenance | Error |
|---|---|---|---|---|
| ⟶ SHOP | ON | ON | OFF | – |
| ⟶ OPERATIONAL | OFF | ON/OFF | OFF | – |
| ⟶ MAINTENANCE | OFF | ON | ON | – |
| ⟶ QUIET | – | – | – | Catastrophic Failure |
| ⟶ PASSIVE | – | – | – | Anomaly |

## 5.2 MAINTENANCE

In the MAINTENANCE state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| MAINTENANCE | Yes | No | Yes | Yes | CBIST, IBIST |

### Transitions

Depending on the DB-25P configuration plug settings and whether errors are detected or not, several transitions from the MAINTENANCE state are possible:

| Transition to | Shop-Mode | Grnd-Mode | Maintenance | Error |
|---|---|---|---|---|
| ⟶ OPERATIONAL | OFF | OFF | OFF | – |
| ⟶ QUIET | – | – | – | Catastrophic Failure |

## 5.3 OPERATIONAL

After a successful initialization and configuration, the switch enters the OPERATIONAL state. In the OPERATIONAL state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| OPERATIONAL | Yes | No | No | Yes | CBIST |

### Transitions

Depending on the DB-25P configuration plug settings and whether errors are detected or not, several transitions from the OPERATIONAL state are possible:

| Transition to | Shop-Mode | Grnd-Mode | Maintenance | Error |
|---|---|---|---|---|
| ⟶ MAINTENANCE | OFF | ON | ON | – |
| ⟶ QUIET | – | – | – | Catastrophic Failure |
| ⟶ QUIET | – | – | – | Anomaly |

## 5.4 PASSIVE

In the PASSIVE state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| PASSIVE | No | No | No | No | No |

### Transitions

No transitions from the PASSIVE state are possible.

## 5.5 QUIET

In the QUIET state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| QUIET | No | No | No | No | No |

### Transitions

The TTE-Switch A664 Lab v2.0 can transition from the QUIET state to the previous state if the previous state was either INIT or OPERATIONAL.

## 5.6 SHOP

In the SHOP state, the TTE-Switch A664 Lab v2.0 provides the following functionality:

| State | Network Traffic | CLI | A615 Dataload | ARP/ICMP/SNMP | BIST Execution |
|---|---|---|---|---|---|
| SHOP | No | Yes | No | No | CBIT |

The SHOP state is a partially non-operational state for factory and development testing only. The SHOP state makes it possible to access the system through the SHOP CLI from a serial terminal.

### Transitions

Depending on the DB-25P configuration plug settings and whether errors are detected or not, the following transition from the SHOP state is possible:

| Transition to | Shop-Mode | Grnd-Mode | Maintenance | Error |
|---|---|---|---|---|
| ⟶ QUIET | – | – | – | Catastrophic Failure |

## 5.7 Error handling

The TTE-Switch A664 Lab v2.0's state machine transitions to either the QUIET or PASSIVE state if it detects a catastrophic failure or anomaly.

### Catastrophic failure examples

- BIST fatal error (e.g., the switch would take permanent damage)
- Unrecoverable position error (e.g., a position could not be read)
- Unrecoverable file error (e.g., no file exists for a given position, CRC error)

### Anomaly examples

- **Maintenance** is **ON** and **Grnd-Mode** is **OFF**
- **Shop-Mode** is **ON** and **Grnd-Mode** is **OFF**

To avoid these anomalies, set **Grnd-Mode** to **ON** by default.

# 6 Creating a switch configuration

## 6.1 Using TTE-Tools for configuration creation

The configuration for the switch and the internal end system is created by the TTE-Tools (minimum recommended version: 5.4.4000) – TTE-Plan, TTE-Build Network Configuration, and TTE-Build Device Configuration.

- **TTE-Plan** is the TTEthernet network design tool. Based on input provided in a network description XML file, TTE-Plan creates the network configuration in a user-convenient way and calculates the TTEthernet schedule for the network. The network description XML file describes the high-level communication requirements for the system, e.g., physical and logical topology, virtual links (VLs), including their IDs, timing requirements and possible frame sizes, as well as synchronization parameters and requirements, e.g., the SAE AS 6802 clock.
- **TTE-Build Network Configuration** knows the specifics of all supported TTEthernet devices. The tool extracts the data from the network configuration, calculates the parameters for the individual devices, and generates the device configuration files.
- **TTE-Build Device Configuration** converts the device configurations from the XML representation into binary configuration images required by the TTEthernet switches and TTEthernet end systems. The XML schemas used to describe these specifications will be publicly available and allow for the highest level of flexibility when TTE-Build Device Configuration is integrated with third-party tools or customer-specific tool chains.

**NOTE** A detailed description of how to create a configuration with the TTE-Tools can be found in the TTE-Plan User Manual [8] and the TTE-Build User Manual [11].

## 6.2 Creating a signature file for switch engine device configuration

A signature check XML file can be created with TTE-Build (minimum recommended version: 5.4.4000). To create a signature file, enter the following command in a Windows command prompt:

```
TTEbuild_batch.exe -command
    "Convert.DcToSignature;SW0.device_config;0xDEADBEEF;SW0.sgn"
```

The items in the command string have the following purpose:

| Command item | Purpose |
|---|---|
| Convert.DcToSignature | Instruct TTE-Build to create a signature file that is based on the provided device configuration. |
| SW0.device_config | (Relative) path and name of a valid switch engine device configuration. |
| 0xDEADBEEF | The seed is used as input value to the CRC function for calculating the checksum. The user can state a seed of their choice. |
| SW0.sgn | (Relative) path and name of the output signature file. |

This example creates a signature file with the name `SW0.sgn` and puts it in the same directory where `TTEbuild_batch.exe` is located. Please note that the output directory needs to exist already!

## 6.3 Configuring the internal end system

The management CPU of the switch uses an internal end system to send and receive frames for data loading via ARINC 615A, ICMP (ping) and diagnostics via SNMP.

**NOTE** Data loading, ICMP and SNMP via best-effort (Ethernet) traffic are always possible by selecting the default configuration via pin programming.

### Rate-constrained management configuration

If a management service such as data loading via ARINC 615A, ICMP, and SNMP shall be available via rate-constrained (i.e., critical) traffic, the corresponding virtual links between the maintenance computer, the switch and the switch-internal end system need to be defined and configured correctly. The minimum VL configuration from a port to the internal end system is 4 user-defined VLs.

For data loading via ARINC 615A, ICMP, SNMP, and other management functionalities via critical traffic, the application ports must be configured. See Table 8 on this page for a list of the default values for internal application ports.

| Name | Port Type[1] | Port[2] | Partition[2] | VL_ID | Protocol |
|---|---|---|---|---|---|
| `#ICMP_TX` | IPSAP | 8 | 1 | 200 | 1 |
| `#ICMP_RX` | IPSAP | 8 | 1 | 100 | 1 |
| `#SNMP_TX` | UDPSAP | 4 | 5 | 203 | 161 |
| `#SNMP_RX` | UDPSAP | 32 | 5 | 103 | 161 |
| `#A615_MAIN_TX` | UDPSAP | 1 | 3 | 202 | 59 |
| `#A615_MAIN_RX` | UDPSAP | 24 | 3 | 102 | 59 |
| `#A615_STATUS_TX` | UDPSAP | 2 | 4 | 202 | 1022 |
| `#A615_STATUS_RX` | UDPSAP | 25 | 4 | 102 | 1022 |
| `#A615_FIND_TX` | UDPSAP | 0 | 2 | 201 | 1001 |
| `#A615_FIND_RX` | UDPSAP | 16 | 2 | 101 | 1001 |

**Table 8:** *Default values for internal application ports for critical and best-effort traffic*

The application port configuration file utilizes the `.ini` file format. Each section in the file represents exactly one configuration for one application port. The example below shows a valid section in the application port configuration file:

```
[#ICMP_RX]
dir = rx
port = 8
part = 1
```

The values for `port` and `part` must match the values of the header file of the internal end system, which is created by the TTE-Tools (see Section 6.1 on the previous page). The application port configuration file must be declared in the `example_configs.ini` file.

The `example_configs.ini` file defines configurations grouped in sections, with each section representing exactly one configuration. The order of sections listed in the `.ini` file implicitly shows the relation between a configuration position selected by pin programming (see Table 3 on page 13) and a section defined in the `.ini` file. This means that the binary files defined in the first section correspond to position 1, while

1. The port type is MACRAW in the case of best-effort traffic.
2. In the case of best-effort traffic, port and partition cannot be changed and are set to `0`.

the binary files defined in the second section correspond to position 2, and so forth.

A section name, which is the name of a configuration, is given between square brackets and can be any string of a maximum of 16 ASCII characters. It is also possible to use blank spaces. The section name is packed into the configuration as well, which can be helpful during debugging. The following example shows a valid section in the `example_configs.ini` file:

| | |
|---|---|
| `[A664_EXAMPLE]` | Section name |
| `swcfg = a664_sw0_0.bin` | Path to the switch device configuration file |
| `escfg = internal_ES.bin` | Path to the end system device configuration file |
| `ipaddr = 10.10.10.10` | IP address of end system/management interface |
| `ipmask = 255.255.255.0` | Subnet mask |
| `gateway = 10.10.10.1` | Gateway of the end system |
| `enablect = 1` | Enable management functionality via critical traffic |
| `aportcfg = example.aport.ini` | Path to the application port configuration file |
| `swcfgsgn = DC\SW0.sgn` | Path to the signature file[1] |

**NOTE** The binary configuration files for the switch and the end system must be located in a path that is relative to the `.ini` file.

## 6.4 Creating the switch configuration image (`CONFIGS_BAK`)

This section describes how to create the switch configuration image with the tool `prepare_configs_smc2.exe` from the TTTech installation DVD. This tool uses binary device configurations created with **TTE-Build Device Configuration** as input.

To run `prepare_configs_smc2.exe`, use the batch file `prepare_configs.bat` that is supplied on the TTTech installation DVD.
Alternatively, you can start the tool via CLI as follows:

```
prepare_configs_smc2.exe example_configs.ini
```

It is mandatory to provide the path to a valid configuration `.ini` file. In addition, the following options can be used:

| | |
|---|---|
| `--outdir` | The output directory for the generated configuration file. Default is the working directory. |
| `--outname` | The output name for the generated configuration file. Default is `CONFIGS_BAK`. |
| `--swap` | If defined, the tool will swap the device configurations of the switch engine and the end system from Little Endian to Big Endian order or vice versa, depending on the original format of the respective device configuration.[2] |
| `--avseed` | The seed is used to calculate the CRC for the autoverify mechanism of the switch engine. Default is `0xFFFFFFFF`.<br>If `--avseed` is not defined and the configuration `.ini` file includes the parameter `swcfgsgn`, the tool `prepare_configs_smc2.exe` calculates the CRC based on the seed stated there.<br>If `--avseed` is not defined and the configuration `.ini` file does not include the parameter `swcfgsgn`, the default value will be used for the calculation. |

This generates the output binary file `CONFIGS_BAK`.

1. The `swcfgsgn` parameter is optional. See also Section 6.4 on the current page.
2. The AeroASIC2 needs Big Endian configurations.

## 6.5 Uploading the switch configuration

The binary configuration file CONFIGS_BAK can be uploaded via A615 data loading or the RS-232 serial interface:

### 6.5.1 Upload via RS-232 serial interface

To upload the configuration via RS-232 serial interface, connect to the switch via Tera Term or any other serial terminal application that is capable of transmitting raw bytes.

1. In the terminal window, enter file integrity to retrieve the states and names of the internal files.
2. Enter file upload CONFIGS_BAK <size in bytes> to prepare the switch for receiving a file. The file size has to be specified in bytes, as displayed in the file properties (Right-click > **Properties** > **Size**).

```
file integrity
FW BAK (FIRMWARE_BAK): ERR: Failed Reading header
FW DEF (FIRMWARE_DEF): ERR: Failed Reading header
CFG ACT (CONFIGS_ACT): OK
CFG BAK (CONFIGS_BAK): OK
CFG DEF (CONFIGS_DEF): ERR: Failed Reading header
>file upload CONFIGS_BAK 5072
Please wait, preparing...
Ready to receive...
```

3. Wait for the switch to get ready. The message Ready to receive... indicates that the switch is ready.
4. Go to **File** > **Send File**. Select the file that is to be uploaded and check the **Binary** file transfer option. Click **Open** to confirm your selection.

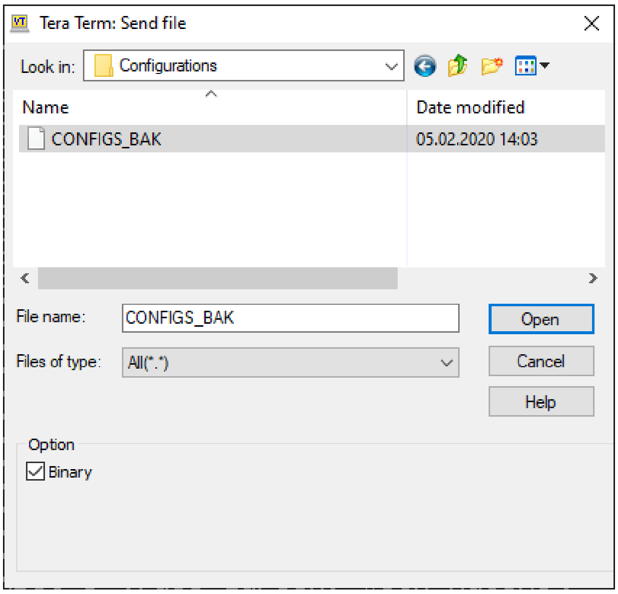



**Figure 10:** *Send file in Tera Term*

5. It will take some time for the switch to process the file. If it does not take the switch any time to process the file, the uploaded file was already present in the switch and nothing was changed. The messages Successfully wrote file and Successfully updated active page indicate that the upload was successful.

```
        Successfully wrote file
        # Successfully updated active page
```

### 6.5.2 Upload via A615 data loading

This section describes how to use the TTTech Data Loader to upload the configuration file to the TTE-Switch A664 Lab v2.0. If you intend to use a different A615-compliant data loader, please see the user documentation for that product.

**NOTE** The TT-615A3-Loader does not calculate a CRC for uploaded files. Therefore it is not fully compliant to ARINC 615A.
The current implementation of the application logs the CRC failure but accepts the file anyway.

The examples below use the following IP addresses:

- Client IP (TTE-Switch A664 Lab v2.0): 10.10.10.10
- Master IP: 10.10.10.30

#### Upload the configuration file

1. Rename the `CONFIGS_BAK` file to `CONFIGS.LUP`.
2. Create the `upload.loading_configuration` text file. This file has to contain all necessary information for identifying the master and its clients, and for performing the upload operation. See an example `upload.loading_configuration` file below:

| | |
|---|---|
| `[MASTER]`<br>`sbnmask=255.255.255.0`<br>`nic=10.10.10.30` | Master section<br>Subnet mask for the master<br>NIC for the master |
| `[UPLOAD]` | Upload operation section |
| `[CLIENT]`<br>`cid=THW001_SW0`<br>`ip2=10.10.10.10`<br>`rootfold=upload_directory` | Client section<br>Client ID<br>Client IP address<br>Root folder for the client. Both absolute and relative paths are accepted. |
| `[FILES]`<br>`fname=CONFIGS.LUP` | List of load files to be uploaded to the client. |

3. In the terminal window, enter `tt_615a3_console_w.exe -c upload.loading_configuration -u` to execute the Upload operation and upload the switch configuration.

#### Operations

The following table shows the operations that can be used with the TT-615A3-Loader and that are relevant to the file upload. For a list of all possible operations, see the TT-615A3-Loader User Manual [12].

| Operation | Command and Description |
|---|---|
| Discover | `tt_615a3_console_w.exe -c cfg.empty -r -l 10.10.10.30 -m 255.255.255.0`<br>Retrieve basic information about every client found in the network. This command requires an existing configuration file which, however, can be empty. |

| Operation | Command and Description |
|---|---|
| Find | `tt_615a3_console_w.exe -c cfg.loading_configuration -f`<br>Check if all clients specified in the configuration file exist in the network. |
| Information | `tt_615a3_console_w.exe -c cfg.loading_configuration -i`<br>Retrieve additional information on each client specified in the configuration file. |
| Upload | `tt_615a3_console_w.exe -c upload.loading_configuration -u`<br>Upload the files specified in the `upload.loading_configuration` to the TTE-Switch A664 Lab v2.0. |

**Table 9:** *TT-615A3-Loader operations*

## 6.6 Configurable Target Hardware ID

The file `thw_id_conf.smc` contains the Target Hardware ID for A615 data loading. The Target Hardware ID has a maximum length of 15 alphanumeric characters. To display the Target Hardware ID, open a CLI window, type `sys thwinfo` and press Enter:

```
>sys thwinfo
Target Hardware Identifier: TTESMC2DEMOAPP
Target Type Name: TTESMC2DEMOAPP
Literal name: TTESMC2DEMOAPP
Manufacturer code: TTT
Target Position: SW0
>
```

To update the Target Hardware ID, the file can be modified via A615 data loading or RS-232 serial interface:

- A615 data loading: Upload the file `thw_id_conf.smc` via data loading.
- RS-232 interface: Open a CLI window, type `file upload thw_id_conf.smc <size in bytes>` and press Enter. For details about this command, see Section 7.5.2 on page 32.

**NOTE** After uploading the file `thw_id_conf.smc`, a reset is necessary to update the Target Hardware ID.

# 7 Diagnosis

## 7.1 Management Information Database

The Management Information Database (MIB) describes the managed objects that can be retrieved via SNMP Version 1 on UDP port 161. Make sure to use the correct IP address according to your loaded configuration.

**NOTE** In your preferred SNMP client, make sure to choose SNMPv1 and disable all the other versions of the SNMP protocol.

The MIB files listed below can be loaded into any SNMPv1-compliant SNMP client. The MIB files contain the following diagnostic information about the switch status:

- `TTE-SMC2-MIB`: Contains information about firmware, configuration, temperatures, voltages, and built-in self-tests (BISTs) (see Section 7.2 on the current page).
- `TTE-SWE-TT-MIB`: Contains all relevant status information and error counters of the switch engine. For details about the switch engine, see the *TTEthernet Switch Interface Control Document* [9].
- `TTE-ES-1-8-MIB`: Contains all relevant status information and error counters of the switch end-system. For more detailed information about the switch end-system, see the *Pegasus End System Core – Interface Control Document* [10].
- `TT-MIB`: Contains definitions.

## 7.2 Built-In Self-Tests (BISTs)

The TTE-Switch A664 Lab v2.0 implements three kinds of BISTs, power-up (PBISTs), continuous (CBISTs), and initiated (IBISTs).

- The PBISTs are executed at startup only.
- The CBISTs are executed continuously, i.e., when **Grnd-Mode** is **ON** and when **Grnd-Mode** is **OFF**.
- The IBISTs are only executed when initiated manually.

The following BIST types determine how the results of a BIST are interpreted:

- bitvector (BITVEC)
- counter (COUNT)
- CRC (CRC)
- temperature (TEMP)
- voltage (VOLT)

The BIST results, which can be retrieved via SNMPv1, are stored in non-volatile memory for ad-hoc or later analysis.
The timestamp of the BIST result is reported in seconds. This timestamp is absolute. It increases while the switch is operational and not in SHOP mode.

A BIST result consists of the following items:

- An index
- The latest value measured

- The number of faulty occurrences
- The timestamp of the first faulty occurrence
- The timestamp of the last faulty occurrence
- The last faulty result value

**NOTE** As long as a certain BIST has never failed, only the index and the latest value measured are reported via SNMP.

For a complete list of implemented BISTs, see Appendix A.

## 7.3 Health message

The TTE-Switch A664 Lab v2.0 sends a health message with a period of 1000 ms in the Best Effort Task-1. The length of the message is the maximum UDP Ethernet frame size (1518 B). The health message is transmitted on port 24.

The health message consists of:

1. A 1-byte free running counter which is incremented with every transmission.
2. A 1-byte error counter for every BIST that is configured to be executed.
3. The status of the health pin as ASCII string: “HEALTHY” or “FAULT”.
4. The state of the TTE-Switch A664 Lab v2.0 application, for example “OPERATIONAL”.
5. The TTE-SMC2 software synchronization state in the form of an ASCII string: “SYNC: <0-7>”

**NOTE** When the TTE-Switch A664 Lab v2.0 is in the SHOP state, Best Effort Task-1 is not executed. Therefore, the switch will only send a health message when it is not in the SHOP state.

## 7.4 Life-sign message

The TTE-Switch A664 Lab v2.0 sends a life-sign message with a period of 1000 ms in the Best Effort Task-2. The length of the message is the minimum UDP Ethernet frame size (64 B). The life-sign message is transmitted on port 24.

The message consists of an ASCII string in the form of “DDDD:HH:MM:SS:mmm”, where:

1. DDDD are days since start-up [0, 999], with any leading zeros being skipped.
2. HH are hours since start-up [0, 23], with a leading zero being skipped.
3. MM are minutes since start-up [0, 59], with a leading zero being skipped.
4. SS are seconds since start-up [0, 59], with a leading zero being written.
5. mmm are milliseconds since start-up [0, 999], with any leading zeros being written.

**NOTE** When the TTE-Switch A664 Lab v2.0 is in the SHOP state, Best Effort Task-2 is not executed. Therefore, the switch will only send a life-sign message when it is not in the SHOP state.

## 7.5 Serial command line interface

A serial command line interface (CLI) that is passive, which means it only shows text messages, is available in the INIT, OPERATIONAL, and MAINTENANCE states. The SHOP mode starts an active CLI, which means that commands can be entered. This section describes the CLI that is available in the SHOP mode.

- SHOP mode can be activated only if **Grnd-Mode** is set to **ON** on the DB-25P configuration plug.
- SHOP mode does not start the firmware and does not allow data loading and SNMP.
- SHOP mode makes it possible to debug and diagnose the switch at a fine-grained level.

Open the CLI window, type `help` and press Enter to get an overview of the available commands:

```
bash> help

help (?)     - Prints information on how to use the serial terminal
swe          - Switch Engine commands
es           - End System commands
mdio         - MDIO commands
shift        - Shift register command
voltage      - Voltage tests
dio          - DIO commands
netcli       - CLI via Ethernet
file         - File commands
sys          - System commands
```

### 7.5.1 Read/write commands

| | |
|---|---|
| `swe rd <addr>` | Reads from a specific address (as defined in the switch IP ICD)<br>**Example:** `swe rd 0x0` reads the device ID of the switch. |
| `swe wr <addr> <val>` | Writes to a specific address. |
| `es rd <addr>` | Reads from a specific address (as defined in the end-system IP). |
| `es wr <addr>` | Writes to a specific address. |
| `mdio rd <addr>` | Reads to the `mdio` bus. |
| `mdio wr <addr> <val>` | Writes to the `mdio` bus |
| `voltage idx` | Reads the voltage for a given index. |
| `voltage temp` | Reads the voltage of the temperature sensor. |
| `voltage smc` | Read all voltages from the SMC board. |
| `voltage ain` | Read all voltages from the AIN pins. |
| `voltage 3v3` | Tests 3V3 over voltage. |
| `voltage list <idx>` | Prints a list of voltage indexes. |

### 7.5.2 File commands

Commands for erasing and uploading files can be useful as a backup if the update of the IP or CONFIG has failed and if the end system cannot be reached through Ethernet:

| | |
|---|---|
| `file erase <filename>` | Erases a file |
| `file upload <filename> <bytes>` | Uploads a file. |

The parameter <filename> can be one of the following names:

| | |
|---|---|
| CONFIGS_BAK | Backup configuration image in the dataload area |
| CONFIGS_DEF | Default configuration image in the dataload area |
| FIRMWARE_BAK | Backup firmware image in the dataload area |
| FIRMWARE_DEF | Default firmware image in the dataload area |

**NOTE** It is not recommended to upload larger files due to the slow transfer speed of the serial interface (2 kb/s).

When using the `file upload` command, you must specify the file size in bytes, as displayed in the file properties (Right-click > **Properties** > **Size**).

```
>file upload thw_id_conf.smc 15
Please wait, preparing...
Ready to receive...
```

Wait until the message `Ready to receive...` appears and then upload the raw bytes (choose the **binary** file transfer option) via your terminal application. See Figure 11 on this page for an example.

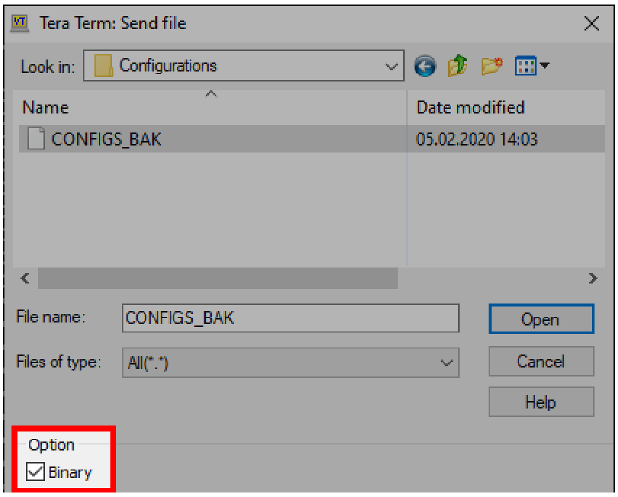



**Figure 11:** *Binary file transfer option in Tera Term*

It will take some time for the switch to process the file. If it does not take the switch any time to process the file, the uploaded file was already present in the switch and nothing was changed.
The message `Successfully wrote file` indicates that the upload has been successful. If a `CONFIGS_BAK` file was uploaded, this message will be followed by the message `Successfully updated active page`.

### 7.5.3 Port commands

The RS-232 command for mirror ports is:

| Command | Arguments | Description |
|---|---|---|
| mirror | <port> [mirror port] [direction] | Get the mirror port for port <port>. Alternatively, set the mirror port of port <port> to [mirror port]. Use the strings RX, TX, or RXTX to set the [direction]. |

### 7.5.4 Event log

The `sys eventlog` command shows the complete event log with a timestamp (in seconds) and the event ID.

# 8 Troubleshooting

If you encounter a malfunction of the TTE-Switch A664 Lab v2.0, there are some basic checks you can perform:

- Is the power supply voltage correct?
- Is the pin programming correct for the desired configuration?
- What do the status LEDs display? See Table 1 on page 11 for details.
- Are all temperatures within the allowed ranges? See Section 7.2 on page 30 for details, and check the SNMP client output for the temperature values of the different sensors.

## 8.1 Customer support information

**Company address:**
Schoenbrunner Str. 7,
A-1040 Vienna, Austria,
Tel. +43 1 585 34 34 – 0,
Fax +43 1 585 34 34 – 90

For technical assistance and support regarding TTTech Computertechnik AG products, please contact our customer support:

- E-Mail: support@tttech.com
- In case of problems with your TTE-Switch A664 Lab v2.0, please have the serial number ready to speed up the processing of your support request. See Section 2.1 on page 7 for information where to find the serial number.

# A List of Built-In Self-Tests

Appendix A shows a complete list of Built-In Self-Tests.

| ID | Name | C | I | PA | P | Type | Reaction | Confirmation | Min | Max | Reconfigurable |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 002 | VOLTAGE_SUPERVISOR | • | | | | BITVEC | LOG | 1 | 0 | 0 | Yes |
| 101 | 0V85_VOLTAGE | • | | | | VOLT | LOG | 3 | 765 mV | 935 mV | Yes |
| 102 | 0V9_VOLTAGE | • | | | | VOLT | LOG | 3 | 810 mV | 990 mV | Yes |
| 103 | 1V2_VOLTAGE | • | | | | VOLT | LOG | 3 | 1080 mV | 1320 mV | Yes |
| 104 | 1V8_VOLTAGE | • | | | | VOLT | LOG | 3 | 1620 mV | 1980 mV | Yes |
| 105 | 2V5_VOLTAGE | • | | | | VOLT | LOG | 3 | 2250 mV | 2750 mV | Yes |
| 106 | 3V3_EXT_VOLTAGE | • | | | | VOLT | LOG | 3 | 2970 mV | 3630 mV | Yes |
| 107 | 3V3_INT_VOLTAGE | • | | | | VOLT | LOG | 3 | 2970 mV | 3630 mV | Yes |
| 003 | 125MHZ_25MHZ_CLCK_COMP | • | | | | BITVEC | LOG | 3 | 0 | 0 | Yes |
| 006 | RLDRAM_DED_CHECK | • | | | | COUNT | RESET_ENFORCED | 1 | 0 | 0 | Yes |
| 110 | RLDRAM_DED_CHECK_CHANGE | • | | | | COUNT | LOG | 1 | 0 | 0 | Yes |
| 007 | RLDRAM_SEC_CHECK | • | | | | COUNT | LOG | 1 | 0 | 0 | Yes |
| 009 | SWE_PORT | • | | | | BITVEC | LOG | 1 | 0 | 0 | Yes |
| 011 | LOOPBACK | | | | • | BITVEC | LOG | 1 | 0 | 0 | No |
| 014 | ASIC_DEV_ID | | • | • | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 0x0032F001 | 0x0032F001 | No |
| 016 | Test WD reset | | | | • | BITVEC | safe mode | 1 | 0 | 0 | No |
| 017 | CPU_BOOT_SELF_TEST | | | • | • | BITVEC | safe mode | 2 | 0 | 0 | No |
| 018 | Watchdog | • | | | | N/A | HW-triggered reset | 1 | 0 | 0 | Yes |
| 021 | FRAM_AVAILABILITY | | | • | • | N/A | safe mode | 2 | 0 | 0 | No |
| 025 | CRC_CHECK | | • | • | • | BITVEC | LOG + explicit SHUT-DOWN_ENFORCED | 2 | 0 | 0 | Yes |
| 026 | CRC_ASIC_CP | • | | | | BITVEC | RESET_ENFORCED | 1 | 0 | 0 | Yes |
| 030 | ASIC_CONFIG_CRC | | • | • | • | BITVEC | LOG + explicit SHUT-DOWN_ENFORCED | 2 | 0 | 0 | Yes |
| 032 | SMC2_TEMPERATURE | • | | | | TEMP | LOG | 3 | -53 °C | 122 °C | Yes |
| 045 | ADC_VERIFY | | | | • | BITVEC | LOG | 2 | 0 | 0 | No |
| 047 | RLDRAM_DED_VERIFY | | | | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 4 | 4 | No |
| 048 | RLDRAM_SEC_VERIFY | | | | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 2 | 2 | No |
| 050 | ASIC_REJECT_CFG | | | | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 5 | 5 | No |
| 051 | Power Supply Voltage Monitor | • | | | | N/A | HW-triggered reset | 1 | 0 | 0 | Yes |
| 053 | RESET_CMD | | | | • | BITVEC | safe mode | 1 | 0 | 0 | No |
| 054 | COMPARE_TEMPERATURE | • | | | | TEMP | LOG | 3 | 0 °C | 29 °C | Yes |
| 056 | ASIC_POS_ID | | • | • | • | BITVEC | LOG + explicit SHUT-DOWN_ENFORCED | 2 | 0 | 0 | Yes |

| ID | Name | C | I | PA | P | Type | Reaction | Confirmation | Min | Max | Reconfigurable |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 061 | FILES_CHECK | • | | | | BITVEC | LOG | 2 | 0 | 0 | Yes |
| 064 | ECC_ASIC_RAM_D | • | | | | BITVEC | RESET_ENFORCED | 1 | 0 | 0 | Yes |
| 065 | ECC_ASIC_RAM_C | • | | | | BITVEC | LOG | 1 | 0 | 0 | Yes |
| 066 | ECC_ASIC_RAM_D_VERIF | | | | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 0 | 0 | No |
| 067 | ECC_ASIC_RAM_C_VERIF | | | | • | BITVEC | SHUTDOWN_ENFORCED | 2 | 0 | 0 | No |
| 070 | MGIO_REG_CHECK | • | | | | BITVEC | RESET_ENFORCED | 2 | 0 | 0 | Yes |
| 074 | FLASH_AVAILABILITY | | • | • | • | BITVEC | safe mode | 2 | 0 | 0 | No |
| 076 | CP_INT_RAM_ECC_D | • | | | | N/A | HW-triggered reset | 1 | 0 | 0 | Yes |
| 077 | CP_INT_RAM_ECC_C | • | | | | COUNT | LOG | 1 | 0 | 0 | Yes |
| 078 | CP_INT_FLA_ECC_D | • | | | | N/A | HW-triggered reset | 1 | 0 | 0 | Yes |
| 079 | CP_INT_FLA_ECC_C | • | | | | COUNT | LOG | 1 | 0 | 0 | Yes |
| 080 | FLASH_MAIN_IMG | | • | • | • | BITVEC | LOG + safe mode | 2 | 0 | 0 | No |
| 081 | RLDRAM_PORT_CRC_CHECK | • | | | | BITVEC | RESET_ENFORCED | 1 | 0 | 0 | Yes |
| 111 | RLDRAM_PORT_CRC_CHECK_CHANGE | • | | | | COUNT | LOG | 2 | 0 | 0 | Yes |
| 082 | CFG_TX_INHIBIT | | | | • | BITVEC | SHUTDOWN_ENFORCED | 1 | 0 | 0 | No |
| 083 | RLDRAM_CRC_PROT | | | | • | COUNT | SHUTDOWN_ENFORCED | 1 | 0 | 0 | No |
| 084 | CPU_CCM_CHECK | • | | | | N/A | HW-triggered reset | 1 | 0 | 0 | Yes |
| 087 | CONFIGURATION_PINS_CHECK | | • | | • | BITVEC | LOG | 2 | 0 | 0 | No |
| 088 | FLASH_WP_CHECK | | • | | • | BITVEC | LOG | 2 | 0 | 0 | Yes |
| 089 | CPU_CONT_SELF_TEST | • | | | | BITVEC | SHUTDOWN_ENFORCED | 1 | 0 | 0 | Yes |
| 090 | SWE_CRC_CHECK | | | | • | BITVEC | SHUTDOWN_ENFORCED | 1 | 0 | 0 | No |
| 091 | CPU_CCM_SELF_TEST | | | | • | BITVEC | safe mode | 1 | 0 | 0 | No |

**Table 10:** *List of Built-In Self-Tests*

**C**…CBIST **I**…IBIST **PA**…PBIST_ABBR **P**…PBIST

# B Serial terminal output at start-up

Appendix B shows a sample CLI output at start-up in SHOP mode.

```
================================================
   TTTech TTE-SMC2 Image 2.5.0
      Jun 10 2020 @ 14:11:50
================================================
[INIT STAGE]
Shutdown cause:0 info:13
Lifetime: 370:27:36
[CONFIGURATION STAGE]
### Mode changed RESTRICTED: OFF
### State changed INIT -> SHOP
Reading Config Pins from Config Plug.
Shop Mode
Initializing SWE...
SWE: Aero ASIC2 SWE IP (0x03030000)
Initializing ES...
TTE-ES: Device ID: 0x99000946, Device Revision:0x0032F001 ES Core
    Version:0x18190000
ES: 1.8.24 (0x0032F001)
Reading Config Pins from Config Plug.
Configured Position: 0
Loading default configuration...
Applied config SW0 from position 0 page CONFIGS_DEF
ID:0 IP:10.10.10.10 MSK:255.255.255.0 GW:10.10.10.255
MAC 02:00:00:00:01:20
Setting PHY 1 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg MODE ->
    AMD SGMII/Copper  SFP at Port 1 unplugged.
Setting PHY 2 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg MODE ->
    AMD SGMII/Copper  SFP at Port 2 unplugged.
Setting PHY 3 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg
Setting PHY 4 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg
Setting PHY 5 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg
Setting PHY 6 (88E1548): COPPER -> 1Gbit/s (full duplex) with AutoNeg
Setting PHY 7 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 8 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 9 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 10 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 11 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 12 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 13 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 14 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 15 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 16 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 17 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 18 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 19 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 20 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 21 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 22 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 23 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 24 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Setting PHY 25 (88E1548): COPPER -> 100Mbit/s (full duplex) with AutoNeg
Initializing Application Ports... Initializing BPDU application ports... done
Management functionality via best effort
Initializing CAL... done
Initializing Network Stack... done
```

```
Initializing Message Router... done
Initializing Routing Table... done
Initializing ICMP... done
Initializing SNMPv1... done
Initializing ARINC 615A-3... done
Finalizing application port configuration... done
Free Memory:43 Kbytes
Successfully initialized System
Starting serial terminal...
>
```

# Glossary

| Entry | Description |
|---|---|
| **A664** | A protocol standard defined by the Aircraft Data Network (ADN) subcommittee of ARINC Airlines Electronic Engineering Committee (AEEC), but now maintained by the Network Infrastructure and Security. |
| **ARINC 615A** | Standard [1] that covers *data loading* over ARINC 664. |
| **ARINC 664** | Defines the use of a deterministic Ethernet network as an avionic databus in modern aircraft. |
| **ARINC** | Aeronautical Radio, Incorporated |
| **BAG** | Bandwidth Allocation Gap |
| **BE** | See **Best-Effort Traffic**. |
| **BIST** | Built-In Self-Test |
| **Best-Effort Traffic** | Ethernet traffic that is not critical traffic (IEEE 802.3 standard traffic). BE traffic will be serviced with lowest priority. |
| **CBIST** | Continuous Built-In Self-Test |
| **CRC** | Cyclic Redundancy Check |
| **DRAM** | Dynamic Random-Access Memory |
| **ESD** | Electrostatic Discharge |
| **ES** | End System |
| **GND** | Ground |
| **IBIST** | Initiated Built-In Self-Test |
| **ICMP** | Internet Control Message Protocol |
| **IEEE** | Institute of Electrical and Electronics Engineers |
| **JTAG** | Joint Test Action Group |
| **MACRAW** | MAC RAW mode |
| **MIB** | Management Information Base |
| **MSB** | Most Significant Bit |
| **NC** | Not Connected |
| **PBIST** | Power-Up Built-In Self-Test |
| **RC** | See **Rate-Constrained Traffic**. |
| **RFU** | Reserved for Future Use |

| Entry | Description |
|---|---|
| **Rate-Constrained Traffic** | TTEthernet traffic that is used for applications with less stringent determinism and real-time requirements than strictly time-triggered applications (ARINC 664 avionics traffic). RC traffic is ued for safety-critical aerospace applications that depend on highly reliable communication and have moderate temporal quality requirements, e.g., multimedia systems. |
| **SFP** | Small Form-factor Pluggable, a compact, optical module transceiver. |
| **SNMP** | Simple Network Management Protocol |
| **SWE** | Switch Engine |
| **TFTP** | Trivial File Transfer Protocol |
| **TT** | See **Time-Triggered Traffic**. |
| **Time-Triggered Traffic** | TTEthernet traffic that is used for applications with stringent determinism and real-time requirements (IEEE 1588-compatible clock synchronization service, real-time control [5]). TT traffic guarantees that bandwidth and latency are pre-defined for each application. TT traffic is used for safety-critical aerospace applications that depend on highly reliable communication and have high temporal quality requirements, e.g., closed loop control systems. |
| **VAC** | Voltage, Alternating Current |
| **VLAN** | Virtual Local Area Network |
| **VL** | See **Virtual Link**. |
| **Virtual Link** | A *logical link* that is used for all critical traffic. For RC traffic, a virtual link has the properties as defined in the ARINC 664 standard. Hence, each virtual link is associated with a dedicated maximum bandwidth that is specified by the minimum frame interval called *bandwidth allocation gap (BAG)* and the maximum frame length. For TT traffic, a virtual link is characterized by exact timing information *and* a maximum frame length. |
| **TTEthernet** | Time-Triggered Ethernet, also *TTE* when used as a prefix. |



Document Number:
D-A664Lab-G-05-001

# References


[1] ARINC. ARINC Report 615A-3, *Software Data Loader Using Ethernet Interface*. International Standard, Aeronautical Radio, Incorporated, 2007.

[2] ARINC. ARINC Specification 664P7-1, *Aircraft Data Network, Part 7, Avionics Full-Duplex Switched Ethernet Network (AFDX®)*. International Standard, Aeronautical Radio, Incorporated, 2009.

[3] IEC. IEC 60297-3-105 Part 3-105: *Dimensions and design aspects for 1U chassis*. International Standard, International Electrotechnical Commission, 2004.

[4] IEEE. 802.1Q™-2011 – *Standard for Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks*. International Standard, Institute of Electrical and Electronics Engineers, 2005.

[5] IEEE. IEEE 1588-2008 – *Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*, Precision Time Protocol (PTP) Version 2. International Standard, Institute of Electrical and Electronics Engineers, 2008.

[6] IEEE. IEEE 802.3™-2008 – *Standard for Ethernet*. International Standard, Institute of Electrical and Electronics Engineers, 2008.

[7] SAE. SAE AS 6802, *Time-Triggered Ethernet*. International Standard, SAE International, 2011.

[8] TTTech. *TTE-Plan "5.0" User Manual*. User Documentation D-TTE-G-01-014, TTTech.

[9] TTTech. *Pegasus Switch Core Interface Control Document*. User Documentation D-STRATPHY-G-10-006, TTTech, 2011.

[10] TTTech. *Pegasus End System (Full IP) Interface Control Document*. Interface Description D-PEGTTE-ID-10-004, TTTech, 2013.

[11] TTTech. *TTE-Build User Manual*. User Documentation D-TTE-G-01-002, TTTech, 2014.

[12] TTTech. TT-A615A3-Loader User Manual. User Documentation TT-A615A3-Loader User Manual, TTTech, 2017.

# Index