Power Distribution System South (PDSS) to Small Sized Telescopes (SST) ICD

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Abbreviations	
CTAO	Cherenkov Telescope Array Observatory
CTAO	Cherenkov Telescope Array Observatory
CTAO-S	Cherenkov Telescope Array SOUTH
ELEC	Electrical Interface
ICD	Interface Control Document
IGDD	Interface General Definition Document
I/F	Interface
IPC	International Protection Code
LPS	Lightning Protection System
MCCB	Moulded Case Circuit Breaker
MEC	Mechanical Interface
PDS	Power Distribution System
SSI	Supplied Services Interface
UPS	Uninterruptible Power Supply

Table of Contents

1 Scope

This document describes the interface requirements and establishes the detailed specifications for the interface between the CTAO Power Distribution System South (PDSS) and Small-Sized telescopes (SST).

The Power Distribution System will be erected at the CTAO SOUTH location with the purpose of distributing 10kV electric power to the SOUTH Array and low-voltage (400V, 50 Hz) electric power to the end users (subsystems) of the array. The Power Distribution System will be equipped with a dynamic UPS.

1.1 Interface Description

The interface described in this ICD is classified according to the CTA Interface Management Plan (IMP) [AD01] and the Interface General Definition Document (IGDD) [AD02].

In particular, this ICD covers the interface category of Electrical Interface (ELEC).
This document is therefore applicable to:

- The CTAO Power Distribution System installed and operated at the SOUTH Site
- All SST telescopes which will be installed in the SOUTH array.

This document does not cover:

- the interface between the parts of the lightning protection systems (LPSs) built onto the CTAO subsystems and those embedded into them, which will be covered by a separate document.
- the equipotential bonding of the SST to the CTAO grounding system.

1.2 Conventions

This document contains two types of items: requirements and information.

- Requirements have to be verified by the party providing the scope of supply herein defined while information items do not.
- Requirements are identified with a requirement tag following the provisional format SST-PDSS-NNNN where NNNN is a unique, non-speaking number. The NNNN identifier does not need to be sequential or continuous. In that way additional requirements can be introduced when revisions of the ICD will be needed.
- Each requirement carries a verification tag that should be taken as a guide for selecting the minimum verification method(s) applicable for that requirement verification (A: Analysis, C: Certification, D: Demonstration, R: review of Design, I: inspection, T: Test).
- Information which is not identified with a tag: this information which is fully binding to this document, refers usually to context, conditions or definitions that have to be taken into consideration for all or for specific requirements.

2 Applicable Documents

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of the specification shall be considered a superseding requirement.

App.Doc	Document Title	Document Number
AD01	*CTA Interface Management Plan (IMP)*	*CTA-NTD-SEI-000000-0001 Issue 1, Rev.: d. 17.01.2020*
AD02	*Interface General Definition Document (IGDD)*	*CTA-STD-SEI-00000-0002*
AD03	*CTA-SOUTH General Electrical Design Specification (complemented by its annexes)*	*CTA-SPE-ELE-414000-001_1c*
AD04	EN 60204-1:2018 Safety of machinery – _Electrical equipment of machines – _Part 1: General requirements	*Version 2018*

3 Definition of Terms

3.1 Terms

Rated voltage
Rated value of the voltage assigned by the manufacturer to a component, device or equipment and to which operation and performance characteristics are referred.

Operating voltage
Value of the voltage under normal conditions, at a given instant and a given point of the system.

Voltage variation
Slow and pseudo-periodic changes, on a daily, weekly or yearly scale, of the voltage at a point in the electric power system, due to changes of the load and to the operation of voltage regulation equipment.

Rated frequency
Frequency of the supply mains in Hertz (Hz) specified by the manufacturer for the normal usage of an equipment.

Frequency Deviation
Difference between the system frequency at a given instant and its nominal value.

Short-time withstand current
The current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour.

Rated Current
The current assigned by the manufacturer for a specified operating condition.

TN-S System
Power system earthing with following principle:

- the secondary star point of the feeding transformer is directly earthed;
- the PE conductor and the N-conductor of the power system are directly connected to that earthing point;
- exposed conductive parts of the downstream installation are connected to that point by protective conductors;
- throughout the whole power system, the protective conductor PE is run separated from the neutral conductor N.

System neutral
The secondary winding star point of the supply transformer or generator.

Power Factor
Under periodic conditions, ratio of the absolute value of the active power P to the apparent power S.

Efficiency
Ratio of output power to input power of a device.

Peak Power Consumption
The largest instance of power usage in a given time frame.

Surge protective device
Device that is intended to protect the electrical apparatus from transient overvoltage and to divert surge currents.

Electrical Lockout
The possibility to mechanically lock energy sources in their OFF position.

4 Interface Definition

4.1 General

The 400V/50Hz CTAO-SOUTH Power Distribution Systems is a TN-S systems where power is supplied to individual telescopes in a radial configuration. The interface being specified at each SST telescope will be comprised of three live conductors (namely, the phase conductors L1, L2, L3), the neutral conductor N as well as the protective earth conductor PE.

The electrical service entrance point of the SST shall be rated for a maximum power demand of P = 18 kW to be supplied by means of a three-phase five-wire system with nominal voltage 230/400 V and a maximum variation range of +5/-3%.

The CTAO Power Distribution System South (PDSS) will be designed in accordance with [AD03].

The neutral conductor N will be earthed in only one point, namely at the neutral point of the low-voltage winding of the distribution transformers. Apart from this single point, the neutral conductor N shall be kept insulated from the protective conductor PE as well as from any other conductors of the earthing system (earth electrodes, earthing conductors, equipotential bonding conductors, etc.). In particular, this insulation shall be maintained at the interface being specified.

Conversely, the protective conductor PE shall be bonded to the SST foundation earthing grid thereby realizing an equipotential bonding.

The SST interface to the SST SOUTH power system is schematically described in figure 1.

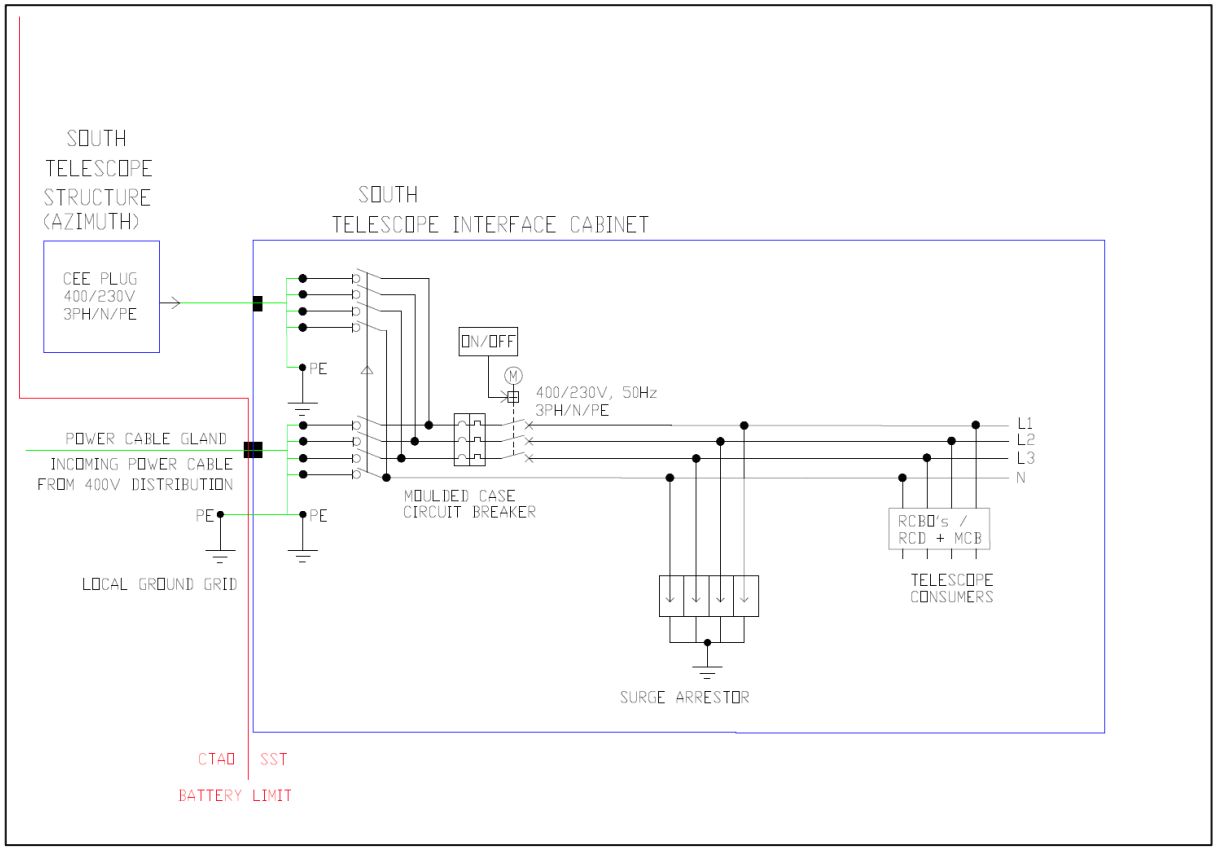

Figure 1: Scheme of CTAO-SOUTH PDS SST Interface

4.2 Electrical Power Interface

4.2.1 CTAO Power Distribution System South: Grid Parameters

	Parameter	Description/value
1	System rated voltage	0.6/1kV
2	Service voltage	400 V AC, 3 phases
3	Type of System	TN-S
4	System neutral	Directly grounded
5	Maximum voltage variation	+5% / -3%, (through 10kV Dynamic UPS)
6	Rated frequency	50 Hz (through 10kV Dynamic UPS)
7	Maximum Frequency Variation	± 1 % (through 10kV Dynamic UPS)
8	Rated short-time withstand current	25kA – 1 s

4.2.2 SST Electrical Power Parameters Requirements

Req. ID	Name of the requirement	Description	Verification method (A,C,D,I,R,T)
SST-PDSS-0010	Power consumption	The SST Peak Power Consumption shall not exceed 15 kW (t < 1min) [B-SST-0620 & B-SST-1570]	A, T
SST-PDSS-0011	Cable design	The Power Distribution System and cable distribution shall be designed for the possibility of increase of the SST peak power consumption of up to 18 kW during the design life of the telescope.	A

SST-PDSS-0020	Overall Power Factor	The SST overall Power Factor at power supply terminals shall not be lower than 0.85.	T
SST-PDSS-0030	Power quality emission limits	The conducted electromagnetic disturbances emitted by the SST Subsystems in correspondence of the interface being specified shall not exceed the limits set in the relevant IEC Specification [AD04].	T
SST-PDSS-0040	Power Quality Immunity limits	The SST shall be immune against the electromagnetic disturbance injected into it by the CTAO PDS in correspondence of the set in the relevant IEC Specification [AD04].	C
SST-PDSS-0050	Rated voltage and frequency	The SST shall be suitable to be operated at 400 VAC, 50 Hz	C

Legend A: Analysis, C: Certification, D: Demonstration, R: review of Design, I: inspection, T: Test

4.3 Physical System Interface

The physical electric power connection between the CTAO- Power Distribution System South and the SST shall be realized by incoming 400V 5-wire power cable (copper conductors) inside the I/F cabinet positioned inside the SST tower.

The following requirements applies to this I/F and the I/F cabinet:

Req. ID	Name of the requirement	Description	Verification method (A,C,D,I,R,T)
SST-PDSS-0100	Electrical connection	The physical connection shall be realized by direct connection of the incoming power cable to the power-change-over switch.	I
SST-PDSS-270	Protection level	With the door closed, the I/F cabinet including all front-operated breakers, indicating instruments, socket-outlets and cable glands, shall provide a degree of protection of IP 55 (as defined in IEC60529) or better.	C
SST-PDSS-280	Protection level	With the door opened, the I/F cabinet shall provide a minimum protection of IP2x (as defined in IEC60529) or better “finger-proof”.	I

SST-PDSS-0120	Cable routing	The incoming power cables shall be routed from the upstream power supply switchgear to the SST foundation directly buried in ground. At the foundation the cables shall be routed inside a duct embedded in the foundation toward its centre, and from there routed up inside the tower.	I, C
SST-PDSS-0121	Cable routing	Technical data of incoming cables shall be considered as defined by CTAO in the Electrical Cable List South (to be issued)	
SST-PDSS-0130	I/F Cabinet	The I/F cabinet shall be provided with the cable glands as required for the 3-phase power input used to supply the SST telescope. The cable glands shall accept steel-wire armoured cables.	I, C
SST-PDSS-0131	I/F Cabinet	Cables shall enter the I/F cabinet through appropriate metallic cable glands on the bottom surface of the cabinet.	I, C
SST-PDSS-0132	I/F Cabinet	The I/F cabinet shall provide internal power terminals with provision for L1, L2, L3, N, PE input power cable connections.	I
SST-PDSS-0133	Interface cabinet free space	The /I/F cabinet shall be chosen to have 30% spare space in view of future expansion and upgrades	R, I
SST-PDSS-0134	I/F Cabinet	A PE connection possibility shall be provided inside the cabinet.	I
SST-PDSS-0140	Circuit Breaker	For feeding the SST the incoming circuit breaker of the I/F cabinet shall be of the MCCB (Moulded Case Circuit Breaker) type breaker.	R, I
SST-PDSS-0141	Circuit breaker	The Incoming circuit breaker shall be motorized and provided with ON and OFF solenoids so to allow a remote power-on and power-off of the SST telescope.	R, I
SST-PDSS-0142	Circuit breakers	The incoming MCCB in the I/F cabinet shall be coordinated with the feeding Circuit Breaker resp. fuses in the upstream distribution system.	A
SST-PDSS--0150	Emergency power connection	5-pole CEE-type power plug shall be provided to allow the electrical connection of an external portable power source for emergency repositioning and park of the telescope in the event of a power blackout.	I
SST-PDSS-0151	Emergency power connection –	A power-change-over switch shall be mounted on the front door of the I/F cabinet to allow switching between the normal power input and the emergency power connection.	I
SST-PDSS-0152	Emergency Power connection	The power-change-over switch that shall have the same electrical rating as the main incoming breaker.	R,I

SST-PDSS-0153	Emergency power connection -	The emergency power connector shall be in an easily accessible position on the outside of the telescope tower.	I
SST-PDSS-0154	Emergency power connection –	The 5-pole power connector on the generator powered side shall be of the type MENNEKES Kupplung PowerTOP® Xtra 14212 and rated for 400V/63A. https://www.mennekes.de/produkt-details/kupplung-powertopr-xtra-14212/	I
SST-PDSS-0155	Emergency power connector	On the telescope interface side, the related 5-pole power inlet shall be of the type MENNEKES Anbaugerätestecker 1259 and rated 400V/63A. https://www.mennekes.de/produkt-details/anbaugeraetestecker-1259/	I
SST-PDSS-0160	Surge arresting device	The I/F cabinet shall be equipped with a surge arresting device on the incoming power lines as defined in the relevant IEC 60204 [AD04].	R, I
SST-PDSS-0170	Environmental Requirements	The interface shall be compatible with operation in the environmental conditions to be encountered at the South site, including the air pressure at elevation up to 2300m ASL	C

Legend A: Analysis, C: Certification, D: Demonstration, R: review of Design, I: inspection, T: Test

5 Safety

5.1 Electrical Lockout

Req. ID	Name of the requirement	Description	Verification method (A,C,D,I,R,T)
SST-PDSS-0200	Electrical Lockout	It shall be possible to mechanically lock the feeding breaker by padlock(s) in the off-position thus providing safety to the personnel performing maintenance on the downstream electrical circuit and connected electrical consumers as per IEC 60204/1 [AD04] paragraph 5.3.3	I

6 Scope of supply of the interface parts

6.1 Scope of Supply by SST

- Design of the I/F cabinet with definition of the fixation inside the SST structure tower including the cable length from the foundation surface.
- Definition of the routing and overall length of cable required to go from the centre of the foundation up to the input terminals of the main breaker inside the I/F cabinet.
- Provision of the I/F Cabinet, its fixation inside the SST structure tower, and cable glands.
- Provision of the external power connection including CEE plug and cable connecting to the I/F cabinet.
- Definition of the tripping overcurrent setting of the MCCB in the I/F cabinet to coordinate with the upstream Power Distribution System.
- Design and provision of the I/F cabinet components needed to realize the functionality demanded by this ICD.
- Design, provision and installation of a surge protection device in the I/F cabinet.

6.2 Scope of Supply by CTAO

- The incoming power cable cross section and outer diameter information shall be provided by CTAO to SST, based on the distance from the substation. This will be reported in a specific document (Cable list for the South) to be issued by CTAO.
- Provision of the foundation including the conduits for the power cables to the centre of foundation.
- Provision and routing of the power distribution cables until the central hole in the foundation.
- Connection of the SST telescope to the power terminals inside the I/F cabinet.