



TRANSNET ENGINEERING TECHNICAL SPECIFICATION

For

Supply of Capacitors for Class 20E, 21E and 22E

Date of release

16 February 2024

Doc. No. RD_RD_KDS_SPEC _0089

Revision 2

Summary of Revision

First Issue: March 2022

Document No.: RD_RD_KDS_SPEC _0089

The following changes have been made in these revisions:

Rev	Description	Author	Date
0	Initial Release	Wing Lau	March 2022
1	Updated Project Timeline and quantities	Wing Lau	January 2024
2	Updated Auxiliary Capacitor technical specification	Wing Lau	February 2024

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Symbols and Abbreviations

TE	Transnet Engineering
TFR	Transnet Freight Rail
PCC	Power Conversion Cubicle

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1. BACKGROUND AND INTRODUCTION

Transnet Engineering (TE) is an Engineering, Manufacturing and Maintenance organisation specialising in Rail Rolling stock and Port Equipment. Over the years, Transnet took delivery of a new generation of electrical locomotives that are now due for maintenance.

2. DOCUMENT SCOPE

2.1. This Technical Specification is for the supply of capacitors for the Class 20E, 21E and 22E locomotives.

2.2. The specification states the minimum requirements relating to the required service of supplying capacitors for the Class 20E, 21E and 22E locomotive, and in no way absolves the supplier from additional duties of ensuring the supplied capacitors are suitable for the mention locomotives.

2.3. For clarity, when used in the context of this document the entities listed below shall have the following meanings:

2.3.1. Capacitor(s) – Refers to the following capacitors for the class 20E, 21E and 22E:

- 2.3.1.1. Auxiliary filtering capacitor
- 2.3.1.2. DC-Link support capacitor
- 2.3.1.3. DC-Link resonant filtering capacitor

2.3.2. Respondent – the person/organisation tendering along with others for the supply of the Goods/Services required under this tender or procurement process.

2.3.3. Successful Bidder – the person/organisation who after submitting the tender response, has successfully passed evaluation and has been awarded the business, thereafter, referred to as the Supplier.

3. APPLICABLE STANDARDS

The respondent shall adhere to the standards that are identified in this document, should the respondent be the successful bidder. The respondent must also provide a list of standards and applicable clauses that they have adhered to other than those mentioned in this specification document, which address the requirements of the requested standards. Refer to section or clause 15 for a comprehensive list of SANS, IEC, EN and Transnet standards to be adhered to.

4. RESPONSE TO TECHNICAL SPECIFICATION

4.1. General

The Respondent must adhere to all the requirements included in this document. Failure to adhere to these requirements may result in the disqualification of the Respondent's submission, subject to the decision of the Transnet adjudication panel.

Transnet reserves the right to disqualify any Respondent should its submission not adhere to all the requirements specified in this document.

4.2. Bidder's Technical Response

4.2.1. Respondents shall provide a clause-by-clause response to this Technical Specification. Failure to comply with this requirement may result in the disqualification of a Respondent.

4.2.2. The responses should therefore contain a clause-by-clause response for each clause in this document, containing at least one of the following answers:

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- **FULLY COMPLIANT:** When the current solution complies already.
- **PARTIAL COMPLIANT:** In case of partial compliance by the bidder.
- **NOT COMPLIANT:** To state that the clause is not met currently and not an option at all.

- 4.2.3. The Respondents must supply an outline proposal of the design, and/or datasheets along with corresponding test results if an existing Unit is quoted. This includes comprehensive information on performance and efficiency.
- 4.2.4. Respondents shall provide drawings, diagrams, and additional literature to clearly describe the operation of the proposed system and highlight any noteworthy features.
- 4.2.5. There shall be a compulsory tender briefing that the respondent shall have to attend before making the tender submission.
- 4.2.6. Respondents shall indicate and respond to the relevant capacitor(s) requirement that they are capable of supplying. The evaluation will be evaluated according to the indicated capacitor(s) that the respondent is capable of supplying.

Table 1: Technical Documentation Checklist

Information Description	Content	Bidder Checklist
Cover letter	Contains information on: - Warranty	
Detailed Technical Offering	Evidence for the responses given in Section 5 - 14 . (Please be very detailed in the information provided)	
List of Documents Supplied for tender	List of technical documents, data sheets and other documents supplied as part of the offering.	
Previous Experience information	- Contact information of relevant reference where a similar type product was supplied, - List of relevant projects and detail, - Company brochure, - OEM authorization letters.	
Technical Documentation	Filled in, signed and stamped Technical Specification Document.	
Project Timeline	Provide delivery dates or lead times for both Prototype and pre-production along with activities accommodating those dates.	

4.3. Alternatives Offered

- 4.3.1. In addition to offers which in the first instance comply with the requirements set forth in this Specification, Respondents may also offer, as alternatives, variations of detail that they consider might be advantageous and acceptable to TE.
- 4.3.2. The respondent may also offer additions to the scope, either being requested or of their own accord. The final decision on the additions rests upon TE.

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4.3.3. This will include existing approved units or Commercial Off-The-Shelf (COTS) that is already in use for railway locomotive system application. In all instances where alternatives are offered for consideration, the following information shall be furnished:

- Type test report
- All relevant technical information (datasheet, previous application used, etc.)
- Provide samples for viewing, static testing, and test fitting.

4.4. Quotation Requirements

4.4.1. TE requires that the price breakdown be made available in at least the following detail:

- Prototyping or development cost (if applicable)
- Prototype Capacitor unit(s)
- Pre-production Capacitor unit(s)

4.4.2. The quantities for the prototype and pre-production unit are as follow:

	Capacitor Type	Qty
Prototype	Auxiliary filtering capacitor	4
	DC-Link Support Capacitor	10
	DC-Link Resonant Capacitor	6
Pre-production	Auxiliary filtering capacitor	8
	DC-Link Support Capacitor	30
	DC-Link Resonant Capacitor	18

5. SCOPE OF GOODS AND SERVICES

5.1. General

- 5.1.1. The successful bidder will supply the capacitor(s) for the class 20E, 21E and 22E locomotive.
- 5.1.2. This Technical Specification is for the development and supply of capacitor(s), as per section 6, for the class 20E, 21E and 22E locomotive.
- 5.1.3. The successful bidder will be given an opportunity to develop the prototype capacitor(s) which will undergo comprehensive testing, thereafter, to supply a pre-production unit which will be an improved or upgraded version of the prototype. Failure to meet the expectation of this technical specification and fit for purpose use will result in discontinuation of business to the successful bidder, to supply the good and service.
- 5.1.4. The prototype will undergo a dummy test fit, and type testing (as per section 8)
- 5.1.5. Only upon acceptance of the prototype shall further approval be given to continue to the next development stage of pre-production.
- 5.1.6. The capacitor will undergo an in-service evaluation, as per section 9, for each phase of development – prototyping, and pre-production unit.
- 5.1.7. The successful bidder shall provide the type test report or service proven reports for the supplied capacitors as per section 8. Only once the type test report or service proven report is satisfactory then shall the capacitors be approved to be fitted in the locomotive for in-service evaluation.

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- 5.1.8. The successful bidder shall collaborate with Transnet for the development, installation, integration, and in-service evaluation on the locomotive.
- 5.1.9. The capacitors supplied by the successful bidders shall undergo in-service evaluation (as per section 10) before further approval will be made for further purchasing.
- 5.1.10. The respondent shall respond to the following table in the right hand most column, with FULLY COMPLIANT, PARTIALLY COMPLIANT, or NOT COMPLIANT, with respect to compliance with the requirement

Note: Scope of Goods and Service is mandatory. A respondent will be disqualified if the answer "Not Compliant" (i.e. response of 'Not Compliant'/ left blank) to any point in the table below.

#	Scope of Goods and Service Required		Response (FULLY COMPLIANT/ PARTIALLY COMAPLIANT/ NOT COMPLIANT)
D.1	Supply	Source and supply of new capacitor as per section 6.	
D.2	Delivery	Delivery of capacitors as mentioned to site (including all freight forwarding and custom cost): - Koedoespoort Depot, - Cnr. Lynette Street and Koedoespoort Rd, - Koedoespoort, - Pretoria - Gauteng - 0186	
D.3	Documentation of Supplied Equipment	Technical Data Sheet	
D.4		Type Test report or service proven report	
D.5	Installation, Testing and Commissioning	Support during the in-service evaluation of the system into the locomotive.	

6. TECHNICAL SPECIFICATION

6.1. General

- 6.1.1. The following technical specification shows the technical information to the items mentioned.
- 6.1.2. The respondent shall supply and complete the right most column in response to the requirements of the equipment.
- 6.1.3. The respondent shall supply supporting document that can demonstrate the ability to supply according to these requirements.
- 6.1.4. The respondent shall attend the compulsory tender briefing before making the tender submission.

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- 6.1.5. The respondent shall measure the mounting bracket for the capacitor that are not included in the components drawing below – before making the tender submission.
- 6.1.6. The successful bidder shall ensure that the mounting brackets attached are correct such that the capacitors are fitted correctly in their respective installation cubicle.
- 6.1.7. The successful bidder shall ensure that there aren't any stresses to any interfacing components or system when installed or when in operation.
- 6.1.8. The successful bidder shall ensure that capacitors make good contact with the interfacing systems.
- 6.1.9. The capacitors will be setup in capacitor bank configuration, therefore, mixing of capacitors with different brand, make and models will not be allowed. A change in capacitor brand, make and models will result in recertification for fit of purpose for the locomotive during the supply period. It is the successful bidder responsibility to notify when a different model, make and model is changed during the supply period and provide the furnished updated data pack. The data pack will include datasheet, type test report, and in-service evaluation report, etc.
- 6.1.10. The successful bidder shall ensure that the OEM, part number, serial number and relevant data labels are placed in a position that are visible to the operator when mounted in the locomotive.

6.2. Environment Requirement

The equipment shall have the following environmental operating requirement:

- 6.2.1. Shock and Vibration resistance: IEC61373:2010
- 6.2.2. Operating Altitude: 2000m

6.3. Auxiliary Capacitor (3-phase)

AC	Characteristic	Parameter	Response [Comply/ Not Comply/ Partially Comply]
AC.1	Rated Capacitance	$3 \times 250 \mu\text{F} \pm 5\%$	
AC.2	Capacitor Connection Configuration	Delta (3-phase)	
AC.3	Weight	approximately 15 kg	
AC.4	Rated Capacity (Q_N)	55 kvar @60hz	
AC.5	Rated Operating Voltage	440 VAC	
AC.6	Rated Current	100 A _{rms}	
AC.7	tanδ (loss angle)	$\leq 0.5 \times 10^{-3}$	
AC.8	Temp. Range	-40°C ~ +70°C	
AC.9	Expected Life	≥100 000 Hours	
AC.10	Self-Healing	Yes	
AC.11	Product Feature	Non-PCB	

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Figure 1: Example - Auxiliary Filtering Capacitor

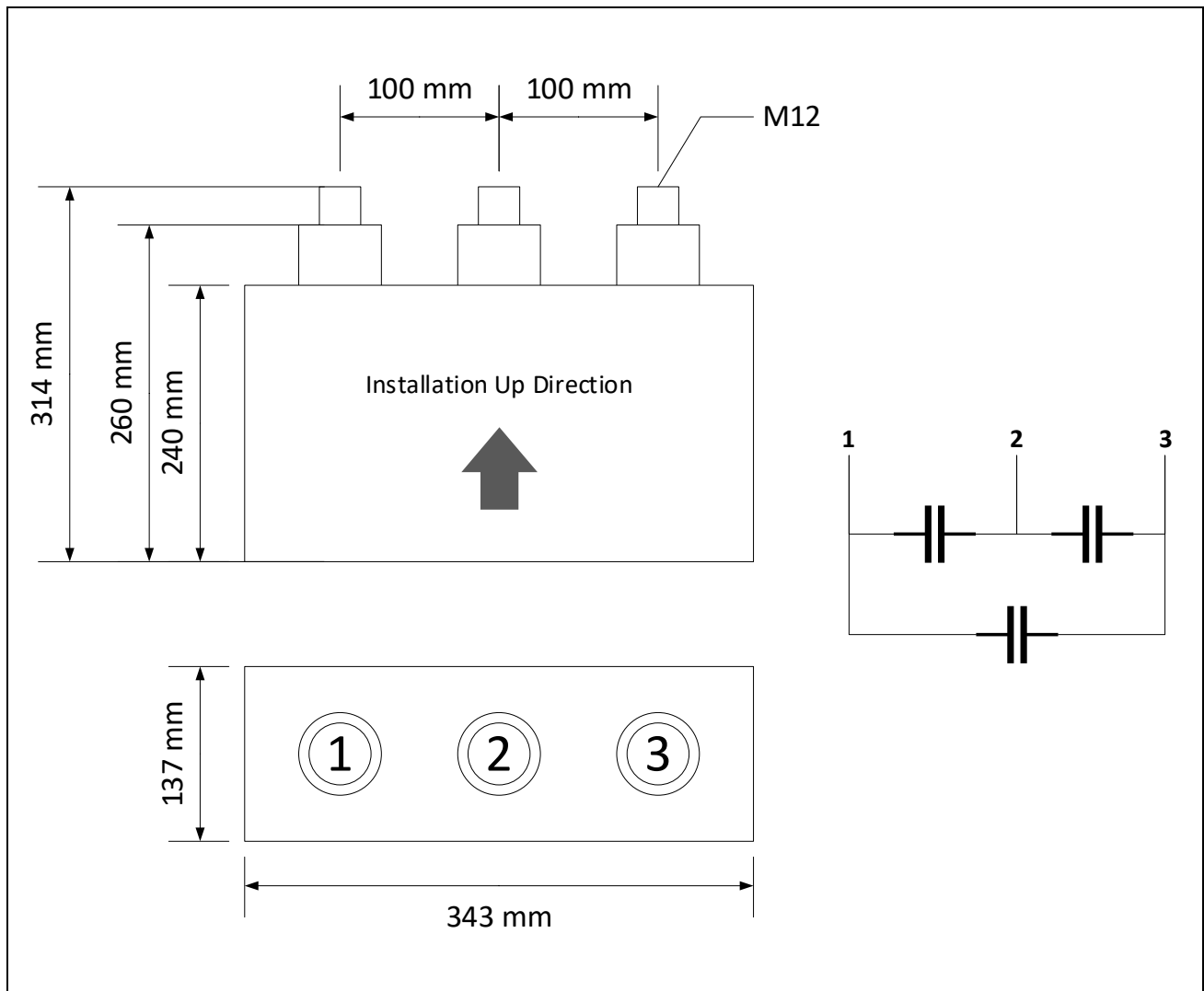


Figure 2: Auxiliary Filtering Capacitor Dimension

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6.4. DC-Link Support Capacitor

DC-SC	Characteristic	Parameter	Response [Comply/ Not Comply/ Partially Comply]
DC-SC.1	Capacitance	1000 μ F $\pm$ 10%	
DC-SC.2	Rated Operating Voltage	4200 VDC	
DC-SC.3	Weight	approximately 45 kg	
DC-SC.4	Rated Current	300 A _{rms}	
DC-SC.5	tan (loss angle)	$\leq 3.0 \times 10^{-3}$ (50Hz, 20°C)	
DC-SC.6	Parasitic Inductance	≤ 200 nH	
DC-SC.7	Temp. Range	-40°C $\sim$ +70°C	
DC-SC.8	Expected Life	$\geq 100\ 000$ Hours	
DC-SC.9	Self Healing	Yes	
DC-SC.10	Dimension	B=175mm; H=600mm; L=340mm	
DC-SC.11	Product Feature	Non-PCB	



Figure 3: Example - DC-Link Support Capacitor

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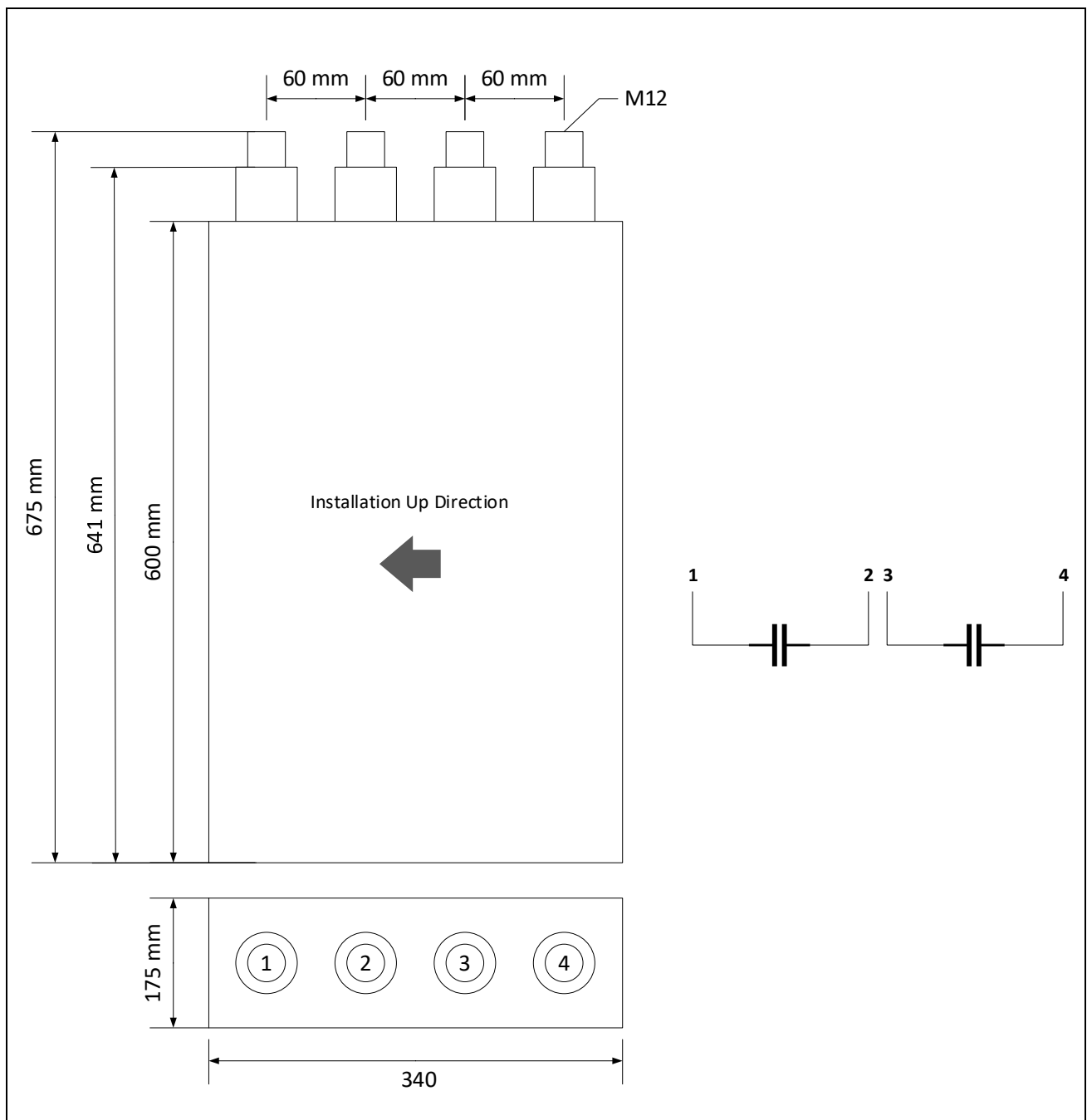


Figure 4: DC-Link Support Capacitor Dimension

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6.5. DC-Link Resonant Filtering Capacitor

DC-FC	Characteristic	Parameter	Response [Comply/ Not Comply/ Partially Comply]
DC-FC.1	Capacitance	1667 $\mu\text{F} \pm 10\%$	
DC-FC.2	Weight	approximately 62 kg	
DC-FC.3	Rated Operating Voltage	4200 VDC	
DC-FC.4	Rated Current	450 A_{rms}	
DC-FC.5	$\tan\delta$ (loss angle)	$\leq 3.0 \times 10^{-3}$ (50Hz, 20°C)	
DC-FC.6	Parasitic Inductance	≤ 200 nH	
DC-FC.7	Temp. Range	-40°C ~ +70°C	
DC-FC.8	Expected Life	$\geq 100\ 000$ Hours	
DC-FC.9	Self-Healing	Yes	
DC-FC.10	Dimension	B=165mm; H=600mm; L=530mm	
DC-FC.11	Product Feature	Non-PCB	



Figure 5: Example - DC-Link Resonant Filtering Capacitor

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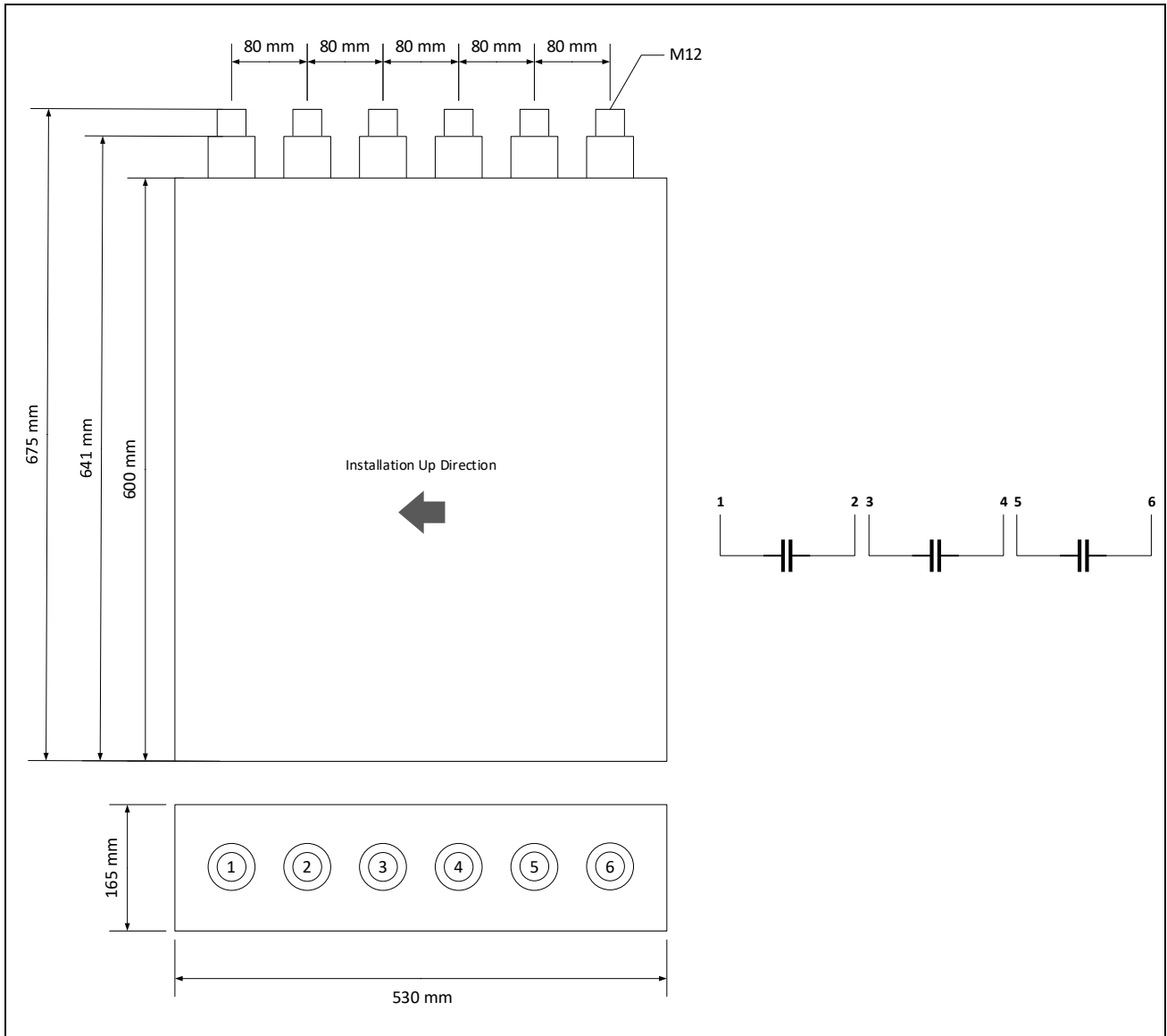


Figure 6:DC-Link Resonant Filtering Capacitor Dimension

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7. CLARIFICATION

- 7.1. The respondent may contact TE at any time through the relevant procurement personnel should any void exist in this specification or there be any uncertainty as a result any contradictory statement within this specification.
- 7.2. All clarification questions directed to TE shall be made in writing through the official channels as detailed in the supporting documents of this procurement event.

8. TYPE TEST

- 8.1. The respondent must also provide a list of standards and applicable clauses that they adhere to other than those mentioned in this specification.
- 8.2. The successful bidder will make available the type test procedure for review and approval, as well as to witness the type tests.
- 8.3. The successful bidder shall conduct and provide a type test report for the supplied capacitor for review and approval.
- 8.4. The respondent may provide an existing type test report for the capacitor if an existing product is available.
- 8.5. Only upon approval of the type test report shall the capacitors be approved to undergo further testing in the locomotive for static and dynamic tests.

9. STATIC AND DYNAMIC TESTING

- 9.1. Static and dynamic testing shall be conducted to determine the capacitors capability to provide the power quality the locomotive and its subsystems needs.
- 9.2. Static and dynamic testing procedure and results shall be discussed, reviewed, and approved with the successful bidder during the prototyping stage.
- 9.3. Only upon approval of the static and dynamic tests shall the capacitors be approved to undergo further in-service evaluation testing.
- 9.4. The locomotive will undergo an Electromagnetic Compatibility (EMC) assessment as part of the static and dynamic testing of the locomotive. This is to ensure that the capacitor meets the required performance. The EMC assessment will need to conform to Transnet standard BBB2274 as specified in section 15.

10. IN-SERVICE EVALUATION

- 10.1. The successful bidder shall make arrangements with Transnet engineers for the installation of the mention capacitors, as per section 4.4.2, for in-service evaluation.
- 10.2. The in-service evaluation testing period, of the installed capacitors, shall be six (6) to twelve (12) months for the prototype, and three (3) month for the pre-production. TE will monitor its in-service performance and follow-up on any possible failures.
- 10.3. The in-service testing period may be shortened or negated if:

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- 10.3.1. The part supplied by the supplier is the same as the original and is certified to be used on the locomotive.
- 10.3.2. When Transnet Engineering's Chief Maintenance Engineer or Fleet Maintenance Owner accepts the product at an earlier stage for operational or other reasons.

10.4. The part shall only be granted approval, for fit for use purpose, once the in-service evaluation testing is successful.

11. MAINTENANCE SUPPORT

- 11.1. The successful bidder will provide maintenance support and spare parts for at minimum period of 10 years.
- 11.2. In the event of repetitive similar failures, the successful supplier shall investigate and support with an updated solution.

12. PROJECT TIMELINES

- 12.1. The Respondent shall include the dates which the Respondent will be able to deliver (for both prototype and pre-production), together with the activities (and accommodating dates).
- 12.2. The following table shall be responded to in the right hand most column, with a YES or NO, with respect to compliance of the requirement.

Note: Scope of Delivery Period for the prototype is mandatory. A respondent will be disqualified if the table is not completed (i.e., blank), indicating the possible delivery date of the prototype. The respondent with the shortest delivery period will receive a higher evaluation score.

#	Prototype Delivery	Response [YES/NO]
D.1	1 Months	
D.2	<3 Months	
D.3	<6 Months	
D.4	Other: _____ (Supplier to stipulate the delivery period of the prototype, please provide reasons of not meeting <6 months delivery date)	

- 12.3. The Respondent is made aware that failure to reach the stated delivery date in 12.2 above may result in disqualification of this tender.

13. QUALITY ASSURANCE

The Supplier to provide certificate of compliance of quality assurance.

14. Warranty

The following table shall be responded to in the right hand most column, with a YES or NO, with respect to compliance with the requirement.

Note: Scope of Warranty Period is mandatory. A respondent will be disqualified if the answer "Not Compliant" (i.e. response No/blank) to any of the points in the table below. The respondent with a longer warranty period will receive a higher evaluation score.

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#	Warranty Period	Response [YES/NO]
W.1	3 Months	
W.2	6 Months	
W.3	12 Months	
W.4	Other: _____ (Supplier to stipulate the warranty period they will provide)	

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15. STANDARDS ADHERENCE

S1	Mandatory for following capacitor	SANS Standards	COMPLY [YES/NO]
S1.1	6.3 6.4 6.5	SANS 10111 (Latest) Engineering Drawing	
S1.2	6.3 6.4 6.5	SANS 60529:2013 Degrees of protection provided by enclosures (IP Code)	
S2		EN Standards	COMPLY [YES/NO]
S2.1	6.3 6.4 6.5	EN 61881 (Latest) Railway applications - Rolling stock equipment - Capacitors for power electronics	
S2.2	6.3 6.4 6.5	EN 50121-3-2: Railway Applications - Electromagnetic compatibility, Rolling stock apparatus	
S2.3	6.3 6.4 6.5	EN 61373:2010 Railway applications – Rollingstock equipment – Shock and vibration tests.	
S3		Transnet Standards/Drawings	COMPLY [YES/NO]
S3.1	6.3 6.4 6.5	BBB2274 (Latest): Electromagnetic compatibility requirements for rolling stock operating on TFR railway lines	
S4		IEC Standards	COMPLY [YES/NO]
S4.1	6.3 6.4 6.5	IEC 61071:2017 Capacitors for power electronics	
S4.2	6.3 6.4 6.5	IEC 60068-1:2013 Environmental testing - Part 1: General and guidance	
S4.3	6.3 6.4 6.5	IEC 60068-2-1:2007 Environmental testing - Part 2-1: Tests - Test A: Cold	
S4.4	6.3 6.4 6.5	IEC 60068-2-2:2007 Environmental testing - Part 2-2: Tests - Test B: Dry heat	
S4.5	6.3 6.4 6.5	IEC 61881-1:2010 Railway applications - Rolling stock equipment - Capacitors for power electronics - Part 1: Paper/plastic film capacitors	
S4.6	6.3 6.4 6.5	IEC 61881-2:2012 Railway applications - Rolling stock equipment - Capacitors for power electronics - Part 2: Aluminium electrolytic capacitors with non-solid electrolyte	
S4.7	6.3 6.4 6.5	IEC 61373:2010 Railway applications - Rolling stock equipment - Shock and vibration tests	
S4.8	6.3	IEC 60831-1:2014 Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1 000 V - Part 1: General - Performance,	

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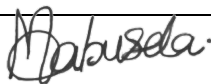
		testing and rating - Safety requirements - Guide for installation and operation	
S4.9	6.3	IEC 60831-2:2014 Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1 000 V - Part 2: Ageing test, self-healing test and destruction test	
S5		ISO Standards	COMPLY [YES/NO]
S5.1		ISO 9001:2015 Quality management systems — Requirements	

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DOCUMENT AUTHORITIES

COMPLIED BY	
Wing Lau	Signed:  Date: 2024/02/16
Engineer TE: System Integration, Assurance and Support	

REVIEWED BY	
Mankoko Mabusela	Signed:  Date: 2024/02/16
Principal Engineer TE: System Integration, Assurance and Support	

APROVED BY	
Mankoko Mabusela	Signed:  Date: 2024/02/16
Principal Engineer TE: System Integration, Assurance and Support	

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