Class 465 & 466

Electric Multiple Units
for British Rail Network SouthEast

GEC ALSTHOM

TRANSPORT

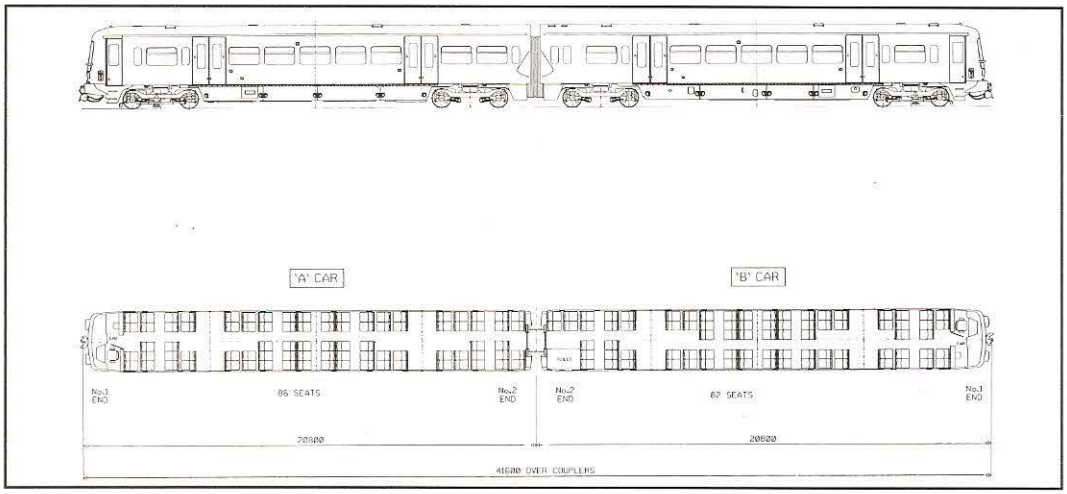
Introduction

Networker is the generic name for the latest generation of electric multiple units that entered service on British Rail's Network SouthEast - Kent Coast lines in October 1992. These new EMUs are of an advanced design which includes three-phase propulsion drives and auxiliary converters.

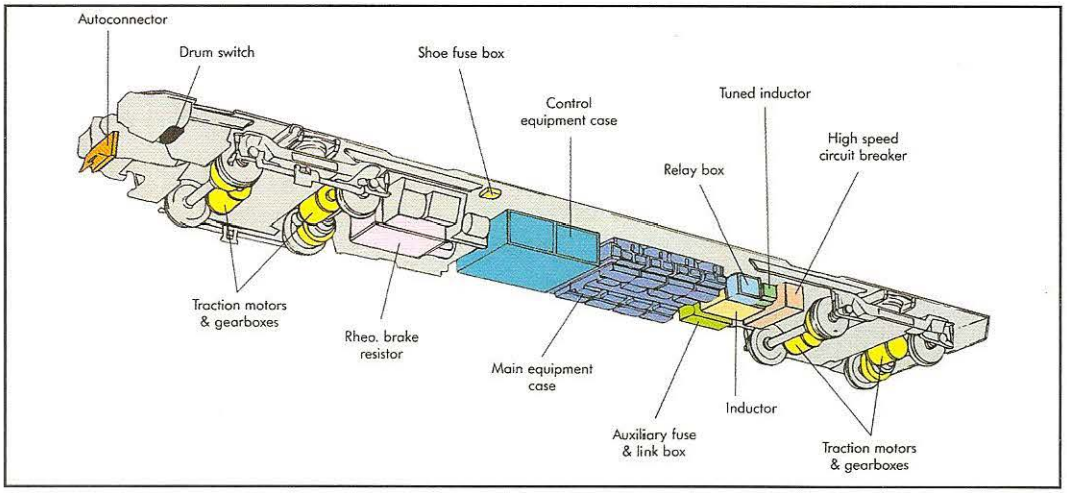
This first fleet of Networker units operates from a third rail, 750 Vdc traction power supply. GEC ALSTHOM Traction Limited supplied electrical equipment for fifty 4-car units (Class 465/2) and forty-three 2-car units (Class 466), which were built by GEC ALSTHOM Metro Cammell.

The Class 465/2 units consist of two driving motors and two trailer cars, and the Class 466 units of one driving motor and one driving trailer car.

As the traction power supply voltage changes from 750 Vdc to 25 kVac across the North/South Thames divide, there is a case for dual-voltage vehicles to provide services that operate through this area.



Layout of a Class 466 car



Underframe view of car showing GEC ALSTHOM Traction equipment

In November 1993, Network South East placed an order for forty-one 4-car dual-voltage (25kV/750V) Networker trains. These are being built by ABB Transportation at their York works. These trains are also equipped with three-phase propulsion drives and auxiliary converters of GEC ALSTHOM Traction design.

The Networker body shells are fabricated from long extruded aluminium sections that are welded together. The vehicles provide a high standard of passenger comfort. The attractive decor and high back seating make for comfortable travelling.

Power-operated sliding plug doors with good illumination of steps and platform give wide access to the car interior. The fitting of cab to signal box radios and dot matrix displays, together with the installation of telephones, greatly increases the level of information available to the passenger.

Inside view of driving cab

Inverter case in the factory showing eight heat sinks for two bogie groups and attachments for mounting only at vehicle sole bar. Each bogie group includes three separate heat sink modules for each phase, plus additional module for the rheostatic braking chopper.

750 VDC Class 465/2 and 466 Networker Trains

The design requirements of the propulsion system include:
- Regenerative and fully rated rheostatic braking
- High input impedance at signalling frequencies
- Limits on signal interference harmonics
- Line current limits due to power supply limitations
- High reliability
- Underframe mounted equipment
- Maximum speed of 120 km/h
- Maximum power per 4-car unit of 1600 kW at 750 Vdc.

The simplified circuit diagram of the equipment is shown in Figure 1.

The design features of the three-phase propulsion equipment include:
- Variable voltage/ variable frequency inverter control
- GTO thyristor technology
- Naturally cooled earthed heat sinks
- Microprocessor electronic control with digital signal processing and incorporating wheelslip/slide protection for the motor car
- A self-ventilated, squirrel cage induction motor, bogie mounted and coupled to the gear box via a flexible drive
- 50 Hz harmonic current monitor
- Iron-cored input filter choke to reduce stray magnetic fields
- High speed dc circuit breaker for total protection of the 750 Vdc equipment on a motor/trailer combination
- Blended brake to maximise use of electric braking
- A speed-set feature to enable the driver to set a maximum speed
- Modular construction
- Modular underframe equipment for attachment at sole bars only
- Two inverters per motor car, and automatic isolation for fault conditions under the direct control of the microprocessor to give bogie group cut-out
- Individual control of each bogie group

Before entry into service, the equipment was subjected to extensive testing which included pre-production prototype system and on-board vehicle testing, type testing, investigative tests, combined testing of production equipment, and extensive testing on first production multiple unit.

Auxiliary Converter

The design requirements of the auxiliary converter were for continuously rated outputs of:
18 kW, 110 Vdc
6 kVA, 240 V rms 50 Hz with less than 12% distortion

The circuit is shown in Figure 2.

Single-phase, square wave ac is produced from the link voltage by switching of four IGBTs. The dc link voltage is produced by a step-down GTO chopper running at 300 Hz, and is controlled to maintain a constant 110 V battery-charging voltage. The stepdown chopper, servo-control and fault status are microprocessor-controlled.
All components are naturally cooled and underframe mounted within a single case. Each trailer car is equipped with an auxiliary converter which supplies two cars.
As well as the auxiliary converter, the underframe case carries:
HT shore supply socket
Shore supply contactor
Auxiliary supply contactor
Saloon heater fuse
240 Vac earth leakage circuit

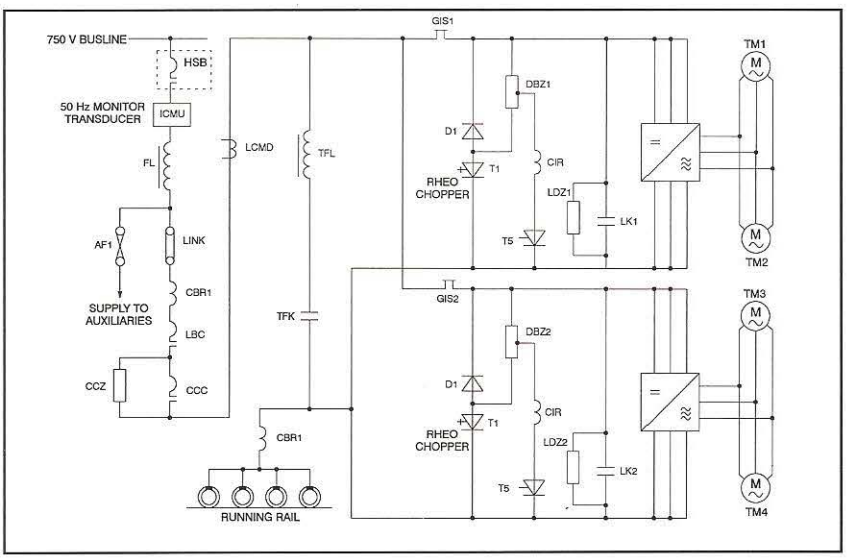
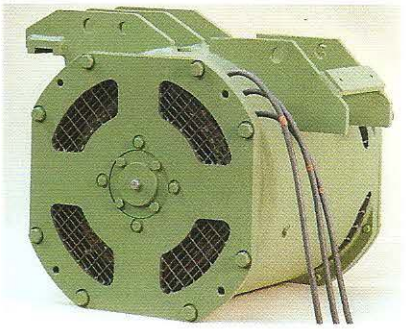


Figure 1.
BR Class 465/2 Networker. Simplified Power Circuit.



Single voltage Networker traction motor.

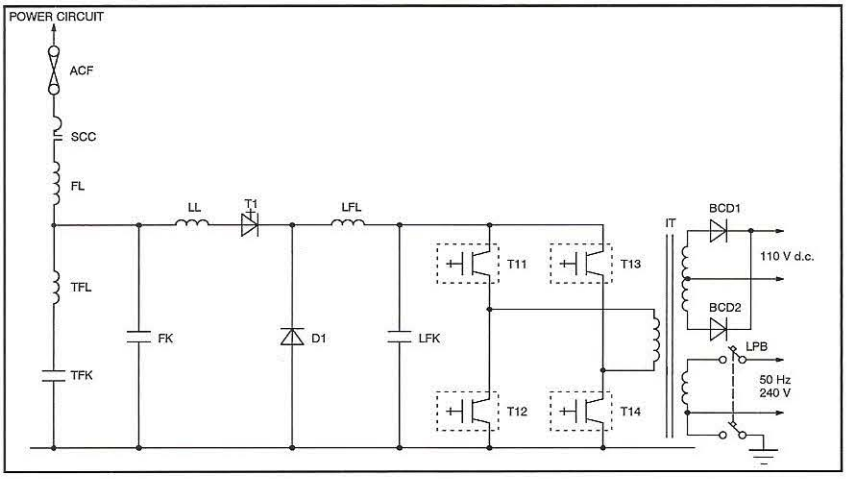
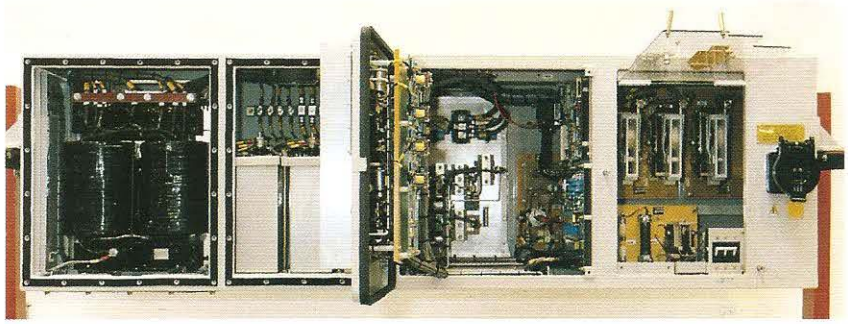
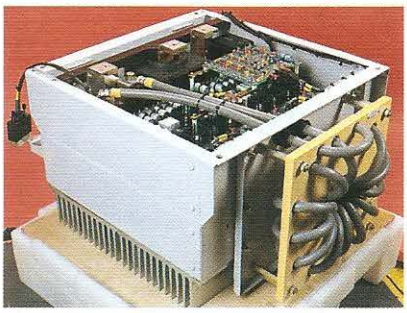


Figure 2.
B.R. Class 465/2 Networker Simplified Auxiliary Convertor Power Circuit.

Traction motor (G352BY) undergoing insulation proving tests at 750 V and 3500 rev/min while submerged in a water tank.



Auxiliary converter underframe case (front view) showing from left to right - output isolation/step down transformer, filter capacitors, IGBT heatsink compartment, contactor compartment and shore supply socket for HT supply to auxiliaries.



Detail of a naturally cooled heat sink module. As well as two GTOs and the associated snubber circuitry, this module includes the electronic drive circuits plus voltage and current monitoring devices.

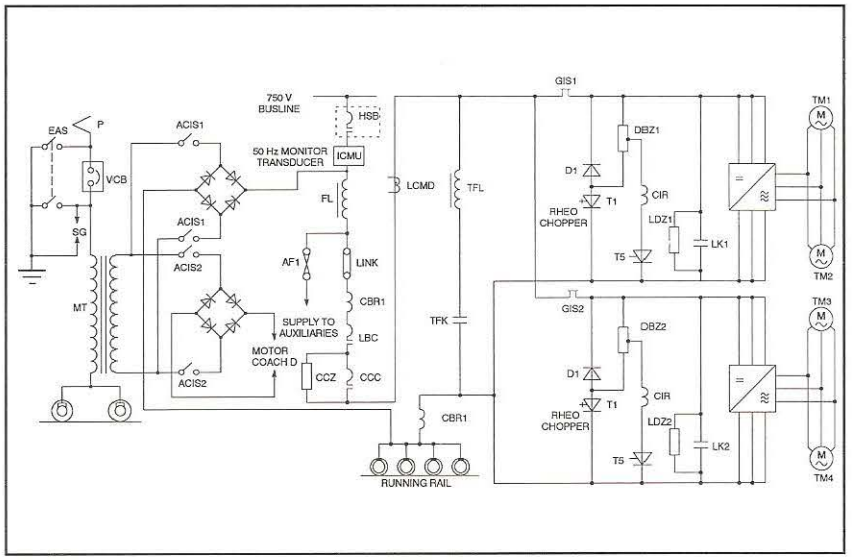
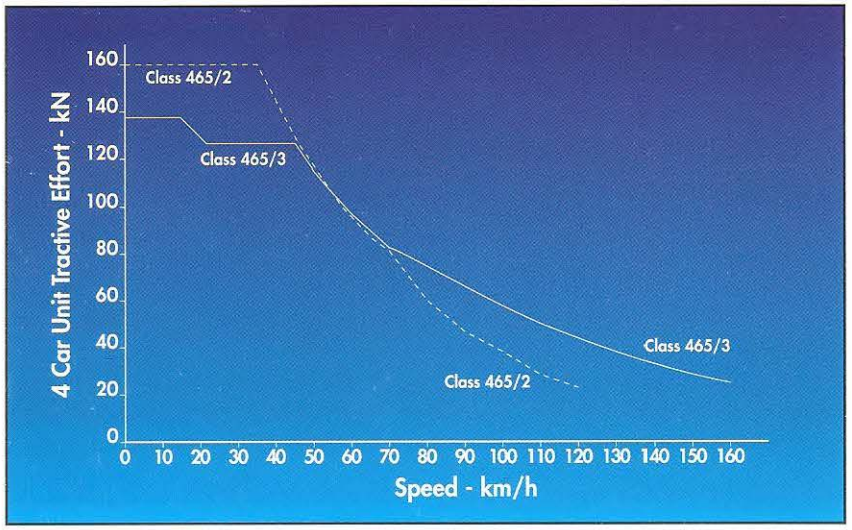
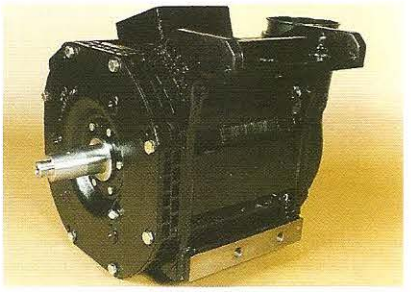


Figure 3.
BR Class 465/3 Networker.
Simplified Power Circuit.



Motoring characteristics of a four-car single and dual voltage Networker 465



A G354 traction motor to be used on dual voltage Networkers.

Dual Voltage Class 465/3 Networker Trains

The requirements for the dual voltage Networker (25 kV/750 Vdc), were the same as for the single voltage Networker, but with a top speed increased to 160 km/h

The circuit used is shown in Figure 3.

The 25 kV ac transformer supplies twc rectifier bridges, one for each motor coach. This is an OFAN (oil forced, air natural) design. The main rectifiers use the same insulation technology as that used for the propulsion inverters and are naturally cooled with earthed heat sinks.

This transformer and the rectifier cases are mounted on the underframe of one of the trailer cars, and supply the dc current for the propulsion inverters and auxiliary converters on the other cars.

The 750 Vdc supply is fed directly to each motor car from the third rail current collection shoegear.

DATA FOR CLASS 465 "NETWORKER" ELECTRIC MULTIPLE UNIT

	Class 465/2	Class 466	Class 465/3
Track gauge	1435 mm	1435 mm	1435 mm
Traffic type	inner suburban	inner suburban	outer suburban
Traction current/supply	750 Vdc,	750 Vdc	750Vdc / 25 kV, 50Hz
No. of vehicles/train	4	2	4
Seating capacity/train	348	168	248
Train tare weight	142 t	71 t	149 t
Train crush weight	202 t	101 t	210 t
Vehicle length	20 m	20 m	20 m
Bodyshell	aluminium	aluminium	aluminium
Doors/car	2 each side	2 each side	2 each side
Wheel diameter	840 mm	840 mm	840 mm
Traction motors	8 x G352BY	4 x G352BY	8 x G354CX
Ventilation	self	self	self
Power rating (peak) } input	2250 kW	1125 kW	2250 kW
Power rating (continuous) } input	1073 kW	537 kW	1256 kW
Traction control	GTO controlled, thyristor inverters supplying three-phase variable frequency / variable voltage		
Maximum speed	120 km/h	120 km/h	160 km/h
Braking system	blended regenerative / rheostatic /pneumatic with slide protection. Mechanical braking is by wheel-mounted discs		

About the GEC ALSTHOM Transport Division

GEC ALSTHOM Traction Limited is part of the GEC ALSTHOM Transport Division. The Division is one of the largest suppliers of railway rolling stock, with an annual turnover of £1000 million, and has 18 000 employees at factories in six countries.

GEC ALSTHOM supplies the world's widest range of electric and diesel locomotives and passenger rolling stock (high speed main-line, suburban, transit, light rail and people-movers). It has been supplying railway rolling stock continuously since 1823 - longer than any other manufacturer in the world. Whilst the majority of its production is in its own factories, technology transfer agreements permit local manufacture in various countries around the world.

GEC ALSTHOM

TRANSPORT

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