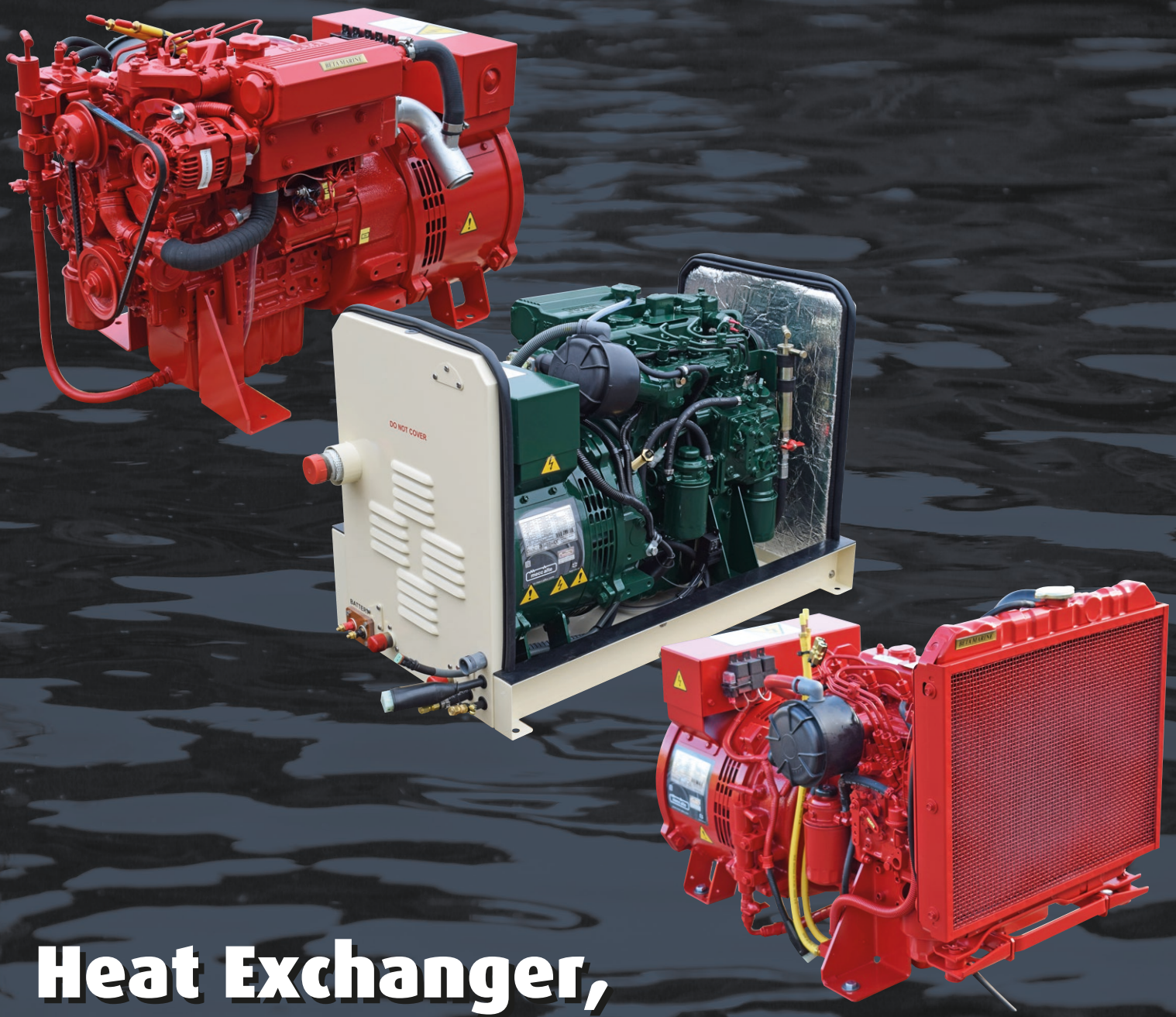
BETA MARINE

Installation Guide & Operators Manual

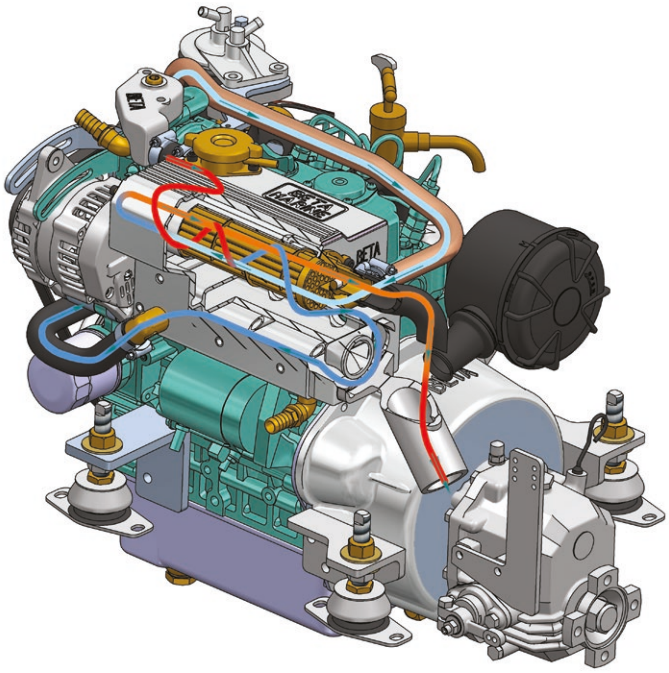


Heat Exchanger, Keel & Radiator Cooled:

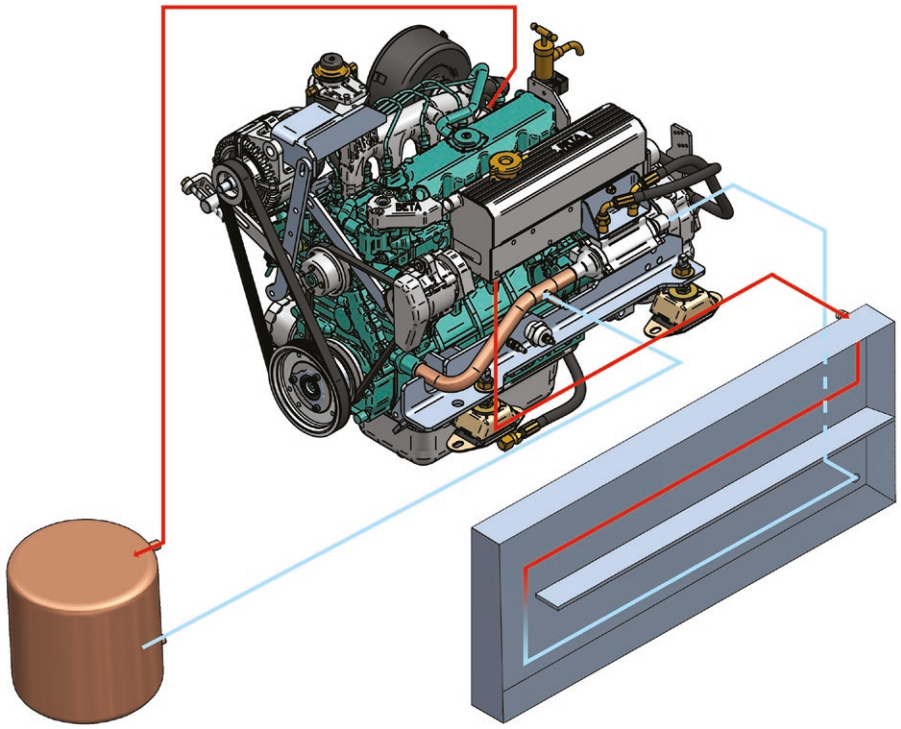
BetaSet-BetaGen Generating Sets

CALIFORNIA - Proposition 65 Warning: Diesel engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects and other reproductive harm.

Typical Heat Exchanger Cooling System



Typical Keel Cooling System



Images Are For Illustration Purposes
& Not Necessarily Representative

Generating Set Identification

IMPORTANT! To ensure you receive the correct advice or parts we ask you to always provide the WOC (Works Order Card) number and/or the engine serial number. Please refer to page 4.

Generating Set Type:		
Power: kVA	Power: kW	Hz Frequency:
BETA WOC NO: K		
Engine Type:		
Alternator Type:		
Purchased From:		
Invoice Number:		
Date Commissioned:		
Specification/Special Details:		

Contents

OPERATION AND MAINTENANCE MANUAL FOR THE FOLLOWING BETA MARINE GENERATING SETS BASED ON KUBOTA DIESEL ENGINES AND MECC ALTE ALTERNATORS

Heat Exchanger, Keel & Radiator Cooled BetaSet-BetaGen Generating Sets

WELCOME TO BETA MARINE

Thank you for purchasing a Beta Marine Generating Set. We have produced this manual to provide you with important information and recommendations to ensure the most trouble free and economical operation of the generating set possible.

As manufacturers, we have written this "Operators Maintenance Manual" from a technical viewpoint assuming a certain amount of understanding of marine engineering. We wish to help you, so if you do not fully understand any phrase or terminology or require any explanations please contact Beta Marine Limited or its distributors and we will be pleased to provide further advice or technical assistance.

All information and recommendations given in this publication are based on the latest information available at the time of publication, and are subject to alteration at any time.

The information given is subject to the company's current conditions of Tender and Sale, is for the assistance of users, and is based upon results obtained from tests carried out at the place of manufacture and in vessels used for development purposes. We do not guarantee the same results will be obtained elsewhere under different conditions.

FREQUENTLY USED TOOLS

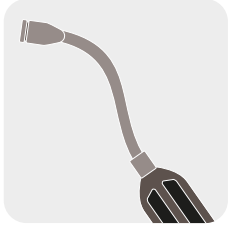
Useful tools when working on BetaSet-BetaGen Generating Sets are:

Sockets and/or spanners in sizes:

10, 12, 13, 14, 17, 19, 22 & 24mm

Allen key in sizes:

5, 6, 8 & 10mm

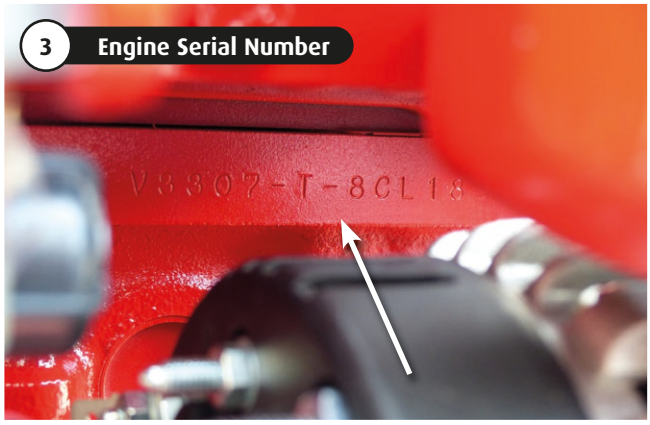


When working on jubilee clips on hoses in restricted or awkward positions a **7mm flex-drive socket** is highly recommended.

GENERATING SET IDENTIFICATION

⚠ IMPORTANT! - To ensure you receive the correct advice or parts we ask you to always provide the WOC (Works Order Card) number and/or the engine serial number

The generating set specification label is located on the engine rocker cover, it details the WOC number, engine type, engine serial number and output in kVA.



The engine serial number is additionally stamped on the engine casing in the locations listed below.

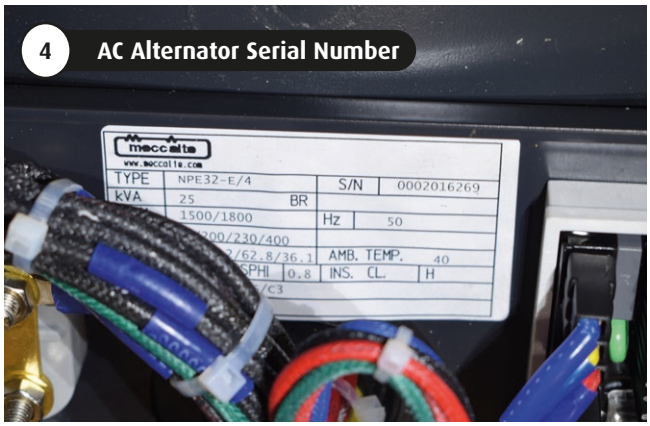
BetaSet-BetaGen 7, 10 & 12
On the crank case above the starter motor on the port side of the engine when viewed from the AC end.

BetaSet-BetaGen 14 & 21
On the crank case below the fuel injection pump on the starboard side of the engine when viewed from the AC end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
On the crankcase behind the fuel filter on the starboard side of the engine when viewed from the AC end.

BetaSet-BetaGen 4/2, 6/2 & 11/2
On the crank case below the fuel injection pump on the starboard side of the engine.

BetaSet-BetaGen 22/2 & 25/2
On the crank case above the starter motor on the port side of the engine.



Additional alternator labels can be found within the alternator terminal box and on the casing detailing the alternator type, serial number, kVA, RPM, Frequency in Hz, Voltage & Phase.

The details on the AC alternator nameplate cover the range of outputs available for that particular frame size and may not be specific to the rating of your generating set.

Please note that the alternator which produces the main AC output of the generating set is sometimes referred to as the generator and should not to be confused with the engine mounted DC starter battery charging alternator.

INITIAL RECEIPT OF THE GENERATING SET

A full inspection of the generating set must be made **immediately on delivery** to confirm that there is no damage. If there is any damage then write this clearly on the delivery note and inform your dealer or Beta Marine by the next working day. It would be appreciated for any claims to be supported by relevant photographs.

GENERATING SET STORAGE

The generating set must be stored in a dry, frost free area and this is best done in its packing case. If storage is to be more than six months then the engine must be inhibited (contact your dealer or Beta Marine). Failure to inhibit the engine may result in the formation of rust in the injection system and the engine bores, this could invalidate the warranty.

Safety Precautions!

WARNING! - ELECTRICITY IS DANGEROUS AND CAN CAUSE DEATH IF THE GENERATING SET IS NOT CORRECTLY INSTALLED, MAINTAINED AND USED

IMPORTANT!

The decision to connect to the AC electrical output terminals of the generating set is the responsibility of a qualified/certified electrician who is also responsible for ensuring the safety, integrity & quality of the electrical circuit being connecting to.

The installation and earthing must be carried out in accordance with the latest edition of the IEE wiring regulations and we recommend that a 'Completion Certificate' is issued by the electrician upon completion.

Standard single phase generating sets leave Beta Marine with one pole earthed (grounded) at the terminal box (neutral bonding).

The generating set should not be used without the Control Module supplied by Beta Marine Ltd.

Beta Marine recommends the installation of an ELCB (Earth Leakage Circuit Breaker) or an RCD (Residual Current Device) and a consumer unit with suitably rated MCB's.

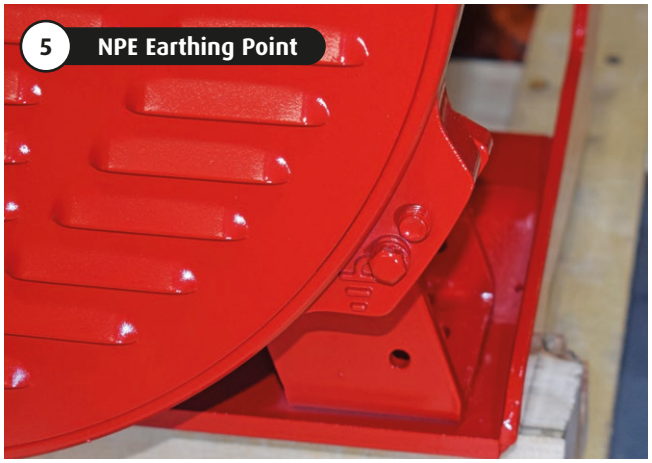
For deck mounted equipment proper waterproof plugs/sockets should be used.

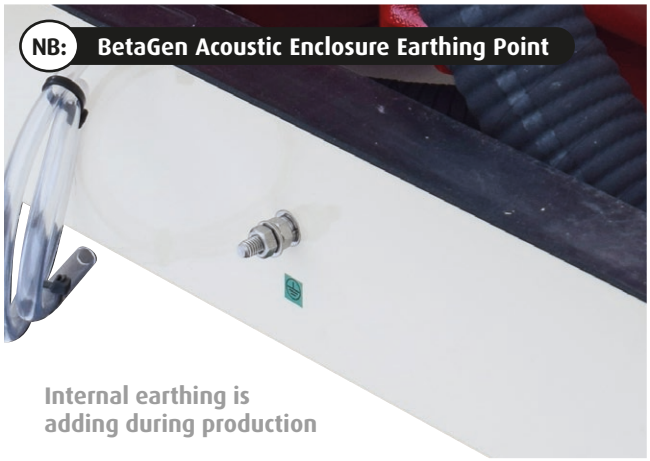
A Keep the generating set, and surrounding area clean, including the area immediately below the engine.

B AC Earthing

The generating set body must be bonded to earth (grounded). It is the responsibility of the installer to ensure that proper earthing is provided to comply with all regulations and legal requirements. The generating set 'Earthing Stud' is located as depicted in images 5, 6 & 7 must be bonded to the vessels hull using suitably rated earthing cable.

AC Earthing points are located:





C Neutral Bonding

On Single Phase BetaSet and BetaGen the neutral terminal is bonded to the earth (ground) bolt in the terminal box. Please refer to image 8. It is the responsibility of the electrician to determine the suitability of this arrangement for the installation. Having the neutral earthed makes the output similar to domestic UK single phase mains supply. On three phase generators the generating set leaves our factory without neutral grounding.

D Drives - Power Take Off Areas

i) Forward End Drive

Generating sets can be supplied with unguarded belt drives to power the fresh water pump and battery charging alternator. The installer must ensure that it is not possible for injury to occur by allowing access to this area of the engine. The three pulleys run at high speed and can cause injury if personnel or clothing come in contact with the belts or pulleys, when the engine is running. If not originally purchased with the generating set, forward end alternator guards are available as an optional extra should they be additionally required.

ii) Power Take Off Shaft (Engine Mounted Option)

Shaft extensions are available as an option and rotate at 1500 - 3600 rev/min. If contact is made with this shaft when the engine is running, injury can occur.

E Exhaust Outlet

Marine diesel generating sets emit exhaust gases at very high temperatures - around 400°C - 500°C. Engines are supplied with either wet exhaust outlet (water injection bend) or dry outlet (dry exhaust stub) - see option list.

At the outlet next to the heat exchanger/header tank, the exhaust outlet can become very hot and if touched, can injure. This must be lagged or avoided by ensuring adequate guarding. It is the responsibility of the installer to lag the exhaust system if a dry system is used. Exhaust gases are harmful if ingested, the installer must therefore ensure that exhaust lines are led overboard and that leakage in the vessel does not occur.

F Fuel

i) Fuel Lines

Diesel engines are equipped with high pressure fuel injection pumps, if leakages occur, or if pipes fracture, fuel at a high pressure can harm personnel. Skin must be thoroughly cleaned in the event of contact with diesel fuel.

ii) Fuel Supply Connections

Engines are supplied with 8mm compression fittings. The installer must ensure that when connections are made, they are clean and free of leaks.

G Oil

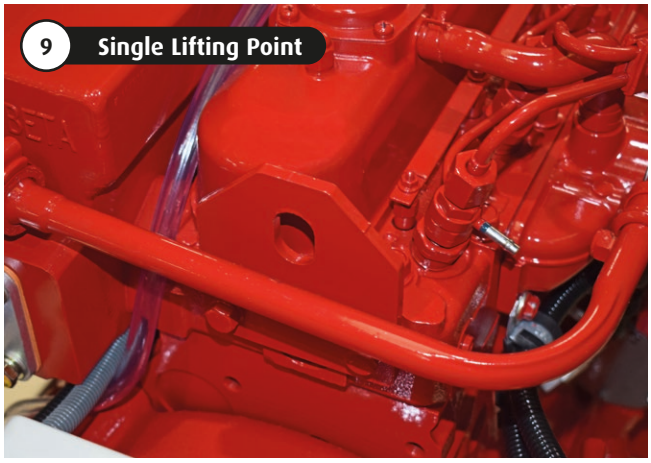
The Beta Marine generating set is supplied with a dipstick for the engine. Ensure the dipstick is returned and secure after checking, if not oil leaks can cause infection when touched. All oil must be removed from the skin to prevent infection.

H Scalding

An engine running under load will have a closed circuit fresh water temperature of 85° to 95°C. The pressure cap on the top of the heat exchanger or keel cooled header tank or radiator cap must not be removed when the engine is running. It can only be removed when the engine is stopped and has cooled down.

I Transportation/Lifting

The generating set is supplied with a single lifting point specifically for the generating set. This is for lifting the generating set only, not the transport pallet and any associated accessories or installation items contained within. Please refer to image 9.



GENERAL DECLARATION

This machinery is not intended to be put into service until it has been incorporated into or with other machinery. It is the responsibility of the purchaser/installer/owner, to ensure that the machinery is properly guarded and that all necessary health and safety requirements, in accordance with the laws of the relevant country, are met before it is put into service.

Signed:

J A Growcoot, C.E.O, Beta Marine Limited.

Specification Parameters

The Performance Class of the generating set is specified in International Standard ISO 8528. BetaSet and BetaGen generating sets perform within the limits of **ISO 8528 Class G1**.

1.1 Frequency Regulation:

Frequency (Hz) regulation depends upon the loading and engine governing. Hz is directly related to engine speed.

Steady state – off load can be up to 8% above the full load Hz. (On many Beta generating sets the off load Hz will be within 5% above the full load speed although this cannot be guaranteed especially on the smaller sets). This is called frequency droop.

- Steady state Hz band is ≤ 2.5%.
- The rated Hz tolerance band is 3.5%

Accordingly, if the full load speed of the engine is set such that the output from the generator is produced at 50Hz (which is 1500 rpm engine speed for a 4-pole generator) the no load Hz could be as much as 54Hz. At loads between full load and no load the frequency will lie between these two figures depending on the magnitude of the load.

The frequency should be stable, at any steady state load, within a band width of 2.5% (1.25Hz). So at 100% load, providing the engine speed is set to produce 50Hz at full load, the frequency can vary within this 2.5% band. For example between 49.4 and 50.6Hz.

1.2 Dynamic Behaviour:

- Transient speed increase when 100% load is removed as a percentage from previous level < 18%.
- Recovery time to new steady state speed band < 10 seconds.
- Transient speed decreases when 100% load is added as a percentage from previous level < -15%
- Recovery time to new steady state speed band < 10 seconds.

1.3 Waveform:

Waveform is not a significant factor for machines for domestic or light industrial applications, the reason being that generator set manufacturers can do little to influence the waveform because it depends upon the cyclic irregularity of the generating set (inherent in the design of the engine and inertia of the set) and the construction of the generator itself which inherently causes harmonics. The connected load can also affect the waveform.

No limits are specified for waveform on these generating sets.

1.4 Voltage Regulation:

'Steady State' voltage regulation will be ± 2.5% (± 3.5% on the smallest machines) of nominal set voltage at any load up to 100% provided the power factor lies in the range 0.8 to unity and provided that the engine is performing in accordance with the parameters detailed in paragraph 1.1 of this specification. In reality voltage regulation will, in many cases, be better than this.

Power factors outside the range 0.8 to unity can affect voltage regulation. Power factor is a function of the connected load. Resistive loads, such as heaters, are unity power factor loads where their kVA equals kW. To obtain the kW rating of any generator set multiply the kVA rating x 0.8. Outputs to loads having other power factors may result in specifications outside the limits mentioned herein.

NB: BetaSet-BetaGen 4/2 and 6/2 are unity factor machines - kVA = kW.

1.5 Power & Voltage:

- Voltage is that set and measured at the generator terminals when the machine is connected to a 'pure' load whose power factor lies between 0.8 and unity. (In the UK the nominal voltage is 400v ± 6%, 3-phase, test voltage for single phase sets can lie between 218v and 244v, hence the nominal voltage to be used under steady state conditions will be 231v on full load).
- Voltage performance of Beta Marine generating sets will be well within the limits specified by **ISO 8528 Class G1**. When large loads are applied the voltage will dip and provided such loads are not too large will recover in a few seconds. In correlation when load is suddenly removed the voltage will rise with similar recovery time.

1.6 De-rating:

The AC alternators are selected so that they are suitable for operation in ship engine rooms with an ambient temperature of up to 45°C. However the diesel engine will be affected by high temperature and humidity.

Engine de-rating must be applied;

- Should the generating set is installed in an acoustic housing or for that matter any restricted area where the fan in the generator is the only means of moving the air. When Beta Marine acoustic housings are used output will be de-rated by 10%.
- The conditions of installation differ from the standard conditions set out in standard ISO 3046, i.e. 100 kPa barometric pressure, 27°C cooling and combustion air temperature and 60% relative humidity. Generally for marine applications only temperature need be considered when de-rate is usually taken as 2% (3% for turbocharged engines) for every 5°C (or part thereof) above 30°C.

1.7 Power Factor:

Power factor is often the cause of much misunderstanding and is a function of the load NOT the generator. However generators are designed to cope with loads at various power factors. Standard machines are designed to cope with loads having power factor between 0.8 and unity being rated by the makers at 0.8 power factor. Some very small machines are designed and rated for unity power factor loads only. A typical unity power factor load would be a heater element (resistive load). A system incorporating a larger electric motor could have a running power factor nearer to 0.8.

Beta Marine Ltd sell equipment producing 'POWER' and the units of power are kilowatts. To change kVA into kW multiply by the power factor. As previously stated the ratings of our generating sets are given in kVA at 0.8 power factor. To obtain the kW rating of the generating set multiply the kVA x 0.8.

By way of an example for a 30 kVA load: A generating set offered on our price list at 33 kVA will drive a system having a rating of 30 kVA where the system power factor is 0.8. However if the system power factor is unity (perhaps all heating and lighting) the kW rating of the system will be 30 x 1 = 30 kW the 33 kVA set will not power it because its rating will only be 33 x 0.8 = 26.4 kW. Consequently a set having a rating of 38.5 kW at 0.8 power factor = 30.8 kVA will be required. (38.5 x 0.8 = 30.8 kW).

This is a simple example not a detailed explanation and is intended for guidance only. The above refers to electrical kW. The relationship between mechanical kW of the engine and electrical kW of generator output depends on the efficiency of the generator and any other driven items. All of our generating sets are fully load tested against a unity power factor load, that is at their kW rating. All sets are also tested to prove that they will provide a 10% overload in accordance with ISO requirements.

For maximum output, continuous output and typical load please refer 'Technical Specification' pages 12 to 29.

BetaSet-BetaGen Compliance

Engine Model	EU Compliance	EU Seagoing Use	EU Inland Use
BetaSet-BetaGen 7	Not Required*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 10	EU.2016/1628 Stage V*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 12	EU.2016/1628 Stage V*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 14	EU.2016/1628 Stage V*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 21	EU.2016/1628 Stage V*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 26	97/68/EU Stage IIIA	R: Yes | C: Yes	R: Yes | C: Yes**
BetaSet-BetaGen 33	97/68/EU Stage IIIA	R: Yes | C: Yes	R: Yes | C: Yes**
BetaSet-BetaGen 40	Not Available	R: Yes | C: Yes	R: No | C: No***
BetaSet-BetaGen 40T - IIIA	97/68/EU Stage IIIA	R: Yes | C: Yes	R: Yes | C: Yes**
BetaSet-BetaGen 49	Not Available	R: Yes | C: Yes	R: No | C: No***
BetaSet-BetaGen 49T - IIIA	97/68/EU Stage IIIA	R: Yes | C: Yes	R: Yes | C: Yes**
BetaSet-BetaGen 4/2	Not Required*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 6/2	Not Required*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 11/2	Not Required*	R: Yes | C: Yes	R: Yes | C: Yes
BetaSet-BetaGen 22/2	Not Available	R: Yes | C: Yes	R: Yes | C: No
BetaSet-BetaGen 25/2	Not Available	R: Yes | C: Yes	R: Yes | C: No

For EPA compliance, all sets must be especially quoted for.

R: Recreational subject to directive 2013/53/EU (RCD2) | C: Commercial

* The BetaSet/BetaGen 7, 10, 12, 14, 21, 4/2, 6/2 & 11/2 have engines below 19kW in power and are currently unregulated for most marine applications. This means they are suitable for use on seagoing, recreational and inland waterways craft.

** Stage IIIA engines are only suitable for craft on European Inland Waterways if the vessel is under 20m in length or under 100m^3 displacement, or the craft is a recreational craft subject to RCD2. Stage IIIA is equivalent to CCNR2.

For craft 20m and over in length and/or 100m^3 and over in displacement, all engines 19kW and over must be Stage V approved.

NB: All passenger vessels carrying 12 or more passengers on European inland waterways must have Stage V approved engines.

(Ref: Directives EU 2016/1628; EU 2016/1629; European Standard for Inland Navigation Vessels ES-TRIN:2019/1).

*** BetaSet/BetaGen 40 & 49 are only Stage II compliant and cannot be used on European Inland Waterways (canals, lakes and rivers including the Rhine).

Important: Local regulations may override these statements and should be checked.

The above statements are Beta Marines interpretation of the afore mentioned directives and standards and are for guidance only. Beta Marine strongly advise that the customer/installer verifies that the intended engine to be supplied and installed meets the requirements of the authority in whose area it is intended that the vessel/craft will operate in.

Beta Marine accept no liability for local non-compliance issues, however, do guarantee to supply engines to meet our current published specification/standard.

NB: The information on this page refers only to constant speed generator set application.

4 - Pole Technical Specifications

BetaSet-BetaGen	7
Kubota/Beta Marine 4 - Cycle Base Engine	BD905 BG
Cylinders - No. In-line	3
Naturally Aspirated	✓
Turbocharged	-
After Treatment - Exhaust Gas Recirculation	-
Combustion Chamber - E TVCS Indirect Injection	✓
Combustion Chamber - E-CDIS Direct Injection	-
Fuel Injection Pressure - **kgf/cm² (psi)**	140 (1991)
Fuel Injection Pump - In-Line	✓
Fuel Injection Timing BTDC - **°/rpm (°/rpm)**	16.5° - 18.5°/1500 (16.5° - 18.5°/1800)
Fuel - Diesel Fuel Oil To EN590 Or ASTM D975	✓
Engine Governor	Mechanical Centrifugal Flyweight
Bore & Stroke - **mm (cu.in)**	72.0 x 73.6 (2.83 x 2.90)
Compression Ratio	23.0
Displacement - **cc (cu in)**	898 (54.86)
Engine Maximum Output - **HP/rpm (HP/rpm)**	10.6/1500 (12.5/1800)
Engine Maximum Output - **kW/rpm (kW/rpm)**	7.9/1500 (9.3/1800)
Engine Prime Output - **HP/rpm (HP/rpm)**	9.6/1500 (11.4/1800)
Engine Prime Output - **kW/rpm (kW/rpm)**	7.2/1500 (8.5/1800)
Starting Aid	Glow Plug
Firing Order	1-2-3
Valve Tip Clearance (Cold) - **mm (in)**	0.145 - 0.185 (0.0057 - 0.0072)
Direction of Rotation - Counter Clockwise (Viewed From The Flywheel)	✓
Lubricating Oil System - Forced By Trochoid Pump	✓
Lubricating Oil Pressure At Rated RPM - **kgf/cm² (psi)**	2.0 - 4.5 (28.0 - 64.0)
Lubricating Oil Capacity Of Standard Sump - **L (U.S gal)**	5.1 (1.3)
Lubricating Oil SAE - **Ambient Temperatures Change Requirement, refer to:**	Page 50
Engine Closed Circuit Coolant Circulation - Pressurised, Forced By Water Pump	✓
Engine Closed Circuit Coolant Capacity - Heat Exchanger Engines - **L (U.S gal)**	7.0 (1.85)
Engine Closed Circuit Coolant - Anti-freeze Mixed 30% > 50% With Water, refer to:	Page 46
Electric Start - 12 Volt Grounded Earth	✓
Electric Start - 12 Volt Insulated Return & 70 Amp Alternator	Opt.
Electric Start - 24 Volt Insulated Return & 55 Amp Alternator	Opt.
Min. Recommended Battery Capacity	70Ah 450CCA

10	12	14
BD1105 BG	BV1505 BG	BD1703BG
3	4	3
✓	✓	✓
-	-	-
-	-	-
✓	✓	✓
-	-	-
140 (1991)	140 (1991)	140 (1991)
✓	✓	✓
15.5° - 17.5°/1500 (16.5° - 18.5°/1800)	15.5° - 17.5°/1500 (16.5° - 18.5°/1800)	17.0° - 19.0°/1500 (17.0° - 19.0°/1800)
✓	✓	✓
All Speed Mechanical	All Speed Mechanical	All Speed Mechanical
78.0 x 78.4 (3.07 x 3.09)	78.0 x 78.4 (3.07 x 3.09)	87.0 x 92.4 (3.43 x 3.64)
24.0	23.0	23.0
1123 (68.53)	1498 (91.41)	1647 (100.5)
13.6/1500 (16.2/1800)	17.8/1500 (21.4/1800)	20.6/1500 (24.3/1800)
10.1/1500 (12.1/1800)	13.3/1500 (16.0/1800)	15.4/1500 (18.1/1800)
12.3/1500 (14.7/1800)	16.2/1500 (19.5/1800)	18.7/1500 (22.1/1800)
9.2/1500 (11.0/1800)	12.1/1500 (14.6/1800)	14.0/1500 (16.5/1800)
Glow Plug	Glow Plug	Glow Plug
1-2-3	1-3-4-2	1-2-3
0.145 - 0.185 (0.0057 - 0.0072)	0.145 - 0.185 (0.0057 - 0.0072)	0.18 - 0.22 (0.0071 - 0.0087)
✓	✓	✓
✓	✓	✓
2.0 - 4.5 (28.0 - 64.0)	2.0 - 4.5 (28.0 - 64.0)	3.0 - 4.5 (42.7 - 64.0)
5.1 (1.3)	6.7 (1.8)	7.0 (1.85)
Page 50	Page 50	Page 50
✓	✓	✓
7.0 (1.85)	7.0 (1.85)	5.5 (1.45)
Page 46	Page 46	Page 46
✓	✓	✓
Opt.	Opt.	Opt.
Opt.	Opt.	Opt.
70Ah 450CCA	94Ah 620CCA	94Ah 620CCA

BetaSet-BetaGen	7
AC Alternator Mecc Alte, Brushless, Single Bearing With IP 22 Protection	✓
Digitally Controlled, Adjustable, Automatic Voltage Regulator	✓

4 - Pole (1500rpm) 50Hz 220/230/240v - 1 Phase	NPE32-B/4
Maximum AC Output - 50Hz 1 Phase @ 1500 rpm - **kVA**	6.6
Prime AC Output - 50Hz 1 Phase @ 1500 rpm **0.8PF - kVA**	6.0
Typical Maximum Load In Amps Per Phase @ 230v Based On **kW** Electrical Load	23.0
Approxomate Fuel Consumption @ Prime Power	2.2

4 - Pole (1500rpm) 50Hz 380/400/415v - 3 Phase	NPE32-B/4
Maximum AC Output - 50Hz 3 Phase @ 1500 rpm - **kVA**	6.7
Prime AC Output - 50Hz 3 Phase @ 1500 rpm **0.8PF - kVA**	6.0
Typical Maximum Load In Amps Per Phase @ 415v Based On **kW** Electrical Load	7.0
Approxomate Fuel Consumption @ Prime Power	2.2

4 - Pole (1800rpm) 60Hz 120v - 1 Phase	NPE32-B/4
Maximum AC Output - 60Hz 1 Phase @ 1800 rpm - **kVA**	7.8
Prime AC Output - 60Hz 1 Phase @ 1800 rpm **0.8PF - kVA**	7.1
Typical Maximum Load In Amps Per Phase @ 120v Based On **kW** Electrical Load	48.0
Approxomate Fuel Consumption @ Prime Power	2.3

4 - Pole (1800rpm) 60Hz 208v - 3 Phase	NPE32-B/4
Maximum AC Output - 60Hz 3 Phase @ 1800 rpm - **kVA**	8.6
Prime AC Output - 60Hz 3 Phase @ 1800 rpm **0.8PF - kVA**	7.8
Typical Maximum Load In Amps Per Phase @ 208v Based On **kW** Electrical Load	17.0
Approxomate Fuel Consumption @ Prime Power	2.2

Approximate Nett Dry Weight	7
BetaSet - **Kg (lbs)**	237
BetaGen - **Kg (lbs)**	290

10	12	14
✓	✓	✓
✓	✓	✓

NPE32-D/4	NPE32-E/4	NPE32-E/4
9.7	12.3	14.0
8.8	11.2	12.7
31.0	39.0	44.0
2.7	3.6	3.6

NPE32-B/4	NPE32-D/4	NPE32-D/4
10.1	13.0	14.5
9.2	11.8	13.2
10.0	13.0	15.0
2.9	3.7	3.7

NPE32-D/4	NPE32-E/4	NPE32-E/4
9.7	15.5	17.6
8.8	14.1	16.0
64.6	94.0	107.0
3.1	4.3	4.6

NPE32-B/4	NPE32-D/4	NPE32-E/4
11.5	16.1	18.2
10.5	14.6	16.5
25.0	33.0	37.0
3.1	4.4	4.6

10	12	14
245	263	390
300	345	498

BetaSet-BetaGen	21
Kubota/Beta Marine 4 - Cycle Base Engine	BV2203 BG
Cylinders - No. In-line	4
Naturally Aspirated	✓
Turbocharged	-
After Treatment - Exhaust Gas Recirculation	-
Combustion Chamber - E TVCS Indirect Injection	✓
Combustion Chamber - E-CDIS Direct Injection	-
Fuel Injection Pressure - **kgf/cm² (psi)**	140 (1991)
Fuel Injection Pump - In-Line	✓
Fuel Injection Timing BTDC - **°/rpm (°/rpm)**	17.0° - 19.0°/1500 (17.0° - 19.0°/1800)
Fuel - Diesel Fuel Oil To EN590 Or ASTM D975	✓
Engine Governor	All Speed Mechanical
Bore & Stroke - **mm (cu.in)**	87.0 x 92.4 (3.43 x 3.64)
Compression Ratio	22.0
Displacement - **cc (cu in)**	2197 (111.31)
Engine Maximum Output - **HP/rpm (HP/rpm)**	27.6/1500 (32.4/1800)
Engine Maximum Output - **kW/rpm (kW/rpm)**	20.6/1500 (24.2/1800)
Engine Prime Output - **HP/rpm (HP/rpm)**	25.2/1500 (29.5/1800)
Engine Prime Output - **kW/rpm (kW/rpm)**	18.8/1500 (22.0/1800)
Starting Aid	Glow Plug
Firing Order	1-3-4-2
Valve Tip Clearance (Cold) - **mm (in)**	0.18 - 0.22 (0.0071 - 0.0087)
Direction of Rotation - Counter Clockwise (Viewed From The Flywheel)	✓
Lubricating Oil System - Forced By Trochoid Pump	✓
Lubricating Oil Pressure At Rated RPM - **kgf/cm² (psi)**	3.0 - 4.5 (42.7 - 64.0)
Lubricating Oil Capacity Of Standard Sump - **L (U.S gal)**	7.6 (2.0)
Lubricating Oil SAE - **Ambient Temperatures Change Requirement, refer to:**	Page 50
Engine Closed Circuit Coolant Circulation - Pressurised, Forced By Water Pump	✓
Engine Closed Circuit Coolant Capacity - Heat Exchanger Engines - **L (U.S gal)**	7.4 (1.96)
Engine Closed Circuit Coolant - Anti-freeze Mixed 30% > 50% With Water, refer to:	Page 46
Electric Start - 12 Volt Grounded Earth	✓
Electric Start - 12 Volt Insulated Return & 70 Amp Alternator	Opt.
Electric Start - 24 Volt Insulated Return & 55 Amp Alternator	Opt.
Min. Recommended Battery Capacity	94Ah 620CCA

26	33	40
BV3300 BG	BV3300 BG	BV3800
4	4	4
✓	✓	✓
-	-	-
-	-	-
✓	✓	✓
-	-	-
140 (1991)	140 (1991)	1st 190 (2702), 2nd 240 (3414)
✓	✓	✓
10.0°/1500 (11.0°/1800)	10.0°/1500 (11.0°/1800)	13.0°/1500 (13.0°/1800)
✓	✓	✓
All Speed Mechanical	All Speed Mechanical	Mechanical Centrifugal Flyweight
98.0 x 110.0 (3.86 x 4.33)	98.0 x 110.0 (3.86 x 4.33)	100.0 x 120.00 (3.94 x 4.72)
22.6	22.6	20.0
1498 (202.5)	3318 (202.5)	3769 (230.0)
41.8/1500 (51.3/1800)	41.8/1500 (51.3/1800)	53.6/1500 (62.8/1800)
31.2/1500 (38.2/1800)	31.2/1500 (38.2/1800)	40.0/1500 (46.9/1800)
38.0/1500 (46.6/1800)	38.0/1500 (46.6/1800)	48.8/1500 (57.2/1800)
28.4/1500 (34.8/1800)	28.4/1500 (34.8/1800)	36.4/1500 (42.7/1800)
Glow Plug	Glow Plug	Intake Air Heater (When Required)
1-3-4-2	1-3-4-2	1-3-4-2
0.23 - 0.27 (0.0091 - 0.0106)	0.23 - 0.27 (0.0091 - 0.0106)	0.23 - 0.27 (0.0091 - 0.0106)
✓	✓	✓
✓	✓	✓
2.0 - 4.0 (28.0 - 56.0)	2.0 - 4.0 (28.0 - 56.0)	2.0 - 4.0 (28.0 - 57.0)
13.2 (3.49)	13.2 (3.49)	13.2 (3.49)
Page 50	Page 50	Page 50
✓	✓	✓
12.5 (3.30)	12.5 (3.30)	10.2 (2.70)
Page 46	Page 46	Page 46
✓	✗	✗
Opt.	Opt.	✓
Opt.	Opt.	Opt.
108Ah 1050CCA	108Ah 1050CCA	108Ah 1050CCA

BetaSet-BetaGen	21
AC Alternator Mecc Alte, Brushless, Single Bearing With IP 22 Protection	✓
Digitally Controlled, Adjustable, Automatic Voltage Regulator	✓

4 - Pole (1500rpm) 50Hz 220/230/240v - 1 Phase	ECP32-2S/4
Maximum AC Output - 50Hz 1 Phase @ 1500 rpm - **kVA**	19.4
Prime AC Output - 50Hz 1 Phase @ 1500 rpm **0.8PF - kVA**	17.6
Typical Maximum Load In Amps Per Phase @ 230v Based On **kW** Electrical Load	61.2
Approxomate Fuel Consumption @ Prime Power	4.7

4 - Pole (1500rpm) 50Hz 380/400/415v - 3 Phase	NPE32-E/4
Maximum AC Output - 50Hz 3 Phase @ 1500 rpm - **kVA**	20.0
Prime AC Output - 50Hz 3 Phase @ 1500 rpm **0.8PF - kVA**	18.2
Typical Maximum Load In Amps Per Phase @ 415v Based On **kW** Electrical Load	20.2
Approxomate Fuel Consumption @ Prime Power	4.8

4 - Pole (1800rpm) 60Hz 120v - 1 Phase	ECP32-2S/4
Maximum AC Output - 60Hz 1 Phase @ 1800 rpm - **kVA**	24.8
Prime AC Output - 60Hz 1 Phase @ 1800 rpm **0.8PF - kVA**	22.5
Typical Maximum Load In Amps Per Phase @ 120v Based On **kW** Electrical Load	150.0
Approxomate Fuel Consumption @ Prime Power	5.8

4 - Pole (1800rpm) 60Hz 208v - 3 Phase	ECP28-2L/4
Maximum AC Output - 60Hz 3 Phase @ 1800 rpm - **kVA**	24.8
Prime AC Output - 60Hz 3 Phase @ 1800 rpm **0.8PF - kVA**	22.5
Typical Maximum Load In Amps Per Phase @ 208v Based On **kW** Electrical Load	51.0
Approxomate Fuel Consumption @ Prime Power	6.0

Approximate Nett Dry Weight	21
BetaSet - **Kg (lbs)**	454
BetaGen - **Kg (lbs)**	580

26	33	40
✓	✓	✓
✓	✓	✓

ECP32-3S/4	ECP32-2M/4	ECP32-3L/4
25.3	32.0	38.5
23.0	29.1	35.0
80.0	101.0	122.0
6.3	7.8	8.5

ECP32-3S/4	ECP32-3S/4	ECP32-3S/4
26.2	33.5	39.6
23.8	30.5	36.0
27.0	34.0	40.0
6.3	7.9	8.5

ECP32-1M/4	ECP32-2M/4	ECP32-2M/4
29.7	39.6	42.9
27.0	36.0	39.0
180.0	240.0	260.0
7.3	9.7	9.2

ECP28-2S/4	ECP32-2S/4	ECP32-3S/4
30.3	39.6	46.2
27.5	36.0	42.0
62.0	81.0	95.0
7.0	9.5	9.4

26	33	40
602	390	390
792	498	498

BetaSet-BetaGen	40T IIIA
Kubota/Beta Marine 4 - Cycle Base Engine	BV3800 BG
Cylinders - No. In-line	4
Naturally Aspirated	-
Turbocharged	✓
After Treatment - Exhaust Gas Recirculation	Internal EGR
Combustion Chamber - E TVCS Indirect Injection	-
Combustion Chamber - E-CDIS Direct Injection	✓
Fuel Injection Pressure - **kgf/cm² (psi)**	1st 190 (2702), 2nd 240 (3414)
Fuel Injection Pump - In-Line	✓
Fuel Injection Timing BTDC - **°/rpm (°/rpm)**	5.5°/1500 (5.5°/1800)
Fuel - Diesel Fuel Oil To EN590 Or ASTM D975	✓
Engine Governor	Electronically Assisted Mechanical
Bore & Stroke - **mm (cu.in)**	100.0 x 120.00 (3.94 x 4.72)
Compression Ratio	19.0
Displacement - **cc (cu in)**	3769 (230.0)
Engine Maximum Output - **HP/rpm (HP/rpm)**	57.5/1500 (67.6/1800)
Engine Maximum Output - **kW/rpm (kW/rpm)**	42.9/1500 (50.5/1800)
Engine Prime Output - **HP/rpm (HP/rpm)**	52.2/1500 (61.5/1800)
Engine Prime Output - **kW/rpm (kW/rpm)**	39.0/1500 (45.9/1800)
Starting Aid	Intake Air Heater (When Required)
Firing Order	1-3-4-2
Valve Tip Clearance (Cold) - **mm (in)**	0.23 - 0.27 (0.0091 - 0.0106)
Direction of Rotation - Counter Clockwise (Viewed From The Flywheel)	✓
Lubricating Oil System - Forced By Trochoid Pump	✓
Lubricating Oil Pressure At Rated RPM - **kgf/cm² (psi)**	2.0 - 4.0 (28.0 - 56.0)
Lubricating Oil Capacity Of Standard Sump - **L (U.S gal)**	13.2 (3.49)
Lubricating Oil SAE - **Ambient Temperatures Change Requirement, refer to:**	Page 50
Engine Closed Circuit Coolant Circulation - Pressurised, Forced By Water Pump	✓
Engine Closed Circuit Coolant Capacity - Heat Exchanger Engines - **L (U.S gal)**	10.2 (2.70)
Engine Closed Circuit Coolant - Anti-freeze Mixed 30% > 50% With Water, refer to:	Page 46
Electric Start - 12 Volt Grounded Earth	✗
Electric Start - 12 Volt Insulated Return & 70 Amp Alternator	✓
Electric Start - 24 Volt Insulated Return & 55 Amp Alternator	Opt.
Min. Recommended Battery Capacity	108Ah 1050CCA

49	49T IIIA
BV3800	BV3800 BG
4	4
✓	-
-	✓
-	Internal EGR
-	-
✓	✓
1st 190 (2702), 2nd 240 (3414)	1st 190 (2702), 2nd 240 (3414)
✓	✓
13°/1500 (13°/1800)	5.5°/1500 (5.5°/1800)
✓	✓
All Speed Mechanical	Electronically Assisted Mechanical
100.0 x 120.00 (3.94 x 4.72)	100.0 x 120.00 (3.94 x 4.72)
20.0	19.0
3769 (230.0)	3769 (230.0)
53.6/1500 (62.8/1800)	57.5/1500 (67.6/1800)
40.0/1500 (46.9/1800)	42.9/1500 (50.5/1800)
48.8/1500 (57.2/1800)	52.2/1500 (61.5/1800)
36.4/1500 (42.7/1800)	39.0/1500 (45.9/1800)
Intake Air Heater (When Required)	Intake Air Heater (When Required)
1-3-4-2	1-3-4-2
0.23 - 0.27 (0.0091 - 0.0106)	0.23 - 0.27 (0.0091 - 0.0106)
✓	✓
✓	✓
2.0 - 4.0 (28.0 - 57.0)	2.0 - 4.0 (28.0 - 56.0)
13.2 (3.49)	13.2 (3.49)
Page 50	Page 50
✓	✓
10.2 (2.70)	10.2 (2.70)
Page 46	Page 46
✗	✗
✓	✓
Opt.	Opt.
108Ah 1050CCA	108Ah 1050CCA

BetaSet-BetaGen	40T IIIA
AC Alternator Mecc Alte, Brushless, Single Bearing With IP 22 Protection	✓
Digitally Controlled, Adjustable, Automatic Voltage Regulator	✓

4 - Pole (1500rpm) 50Hz 220/230/240v - 1 Phase	ECP32-3L/4
Maximum AC Output - 50Hz 1 Phase @ 1500 rpm - **kVA**	40.0
Prime AC Output - 50Hz 1 Phase @ 1500 rpm **0.8PF - kVA**	36.4
Typical Maximum Load In Amps Per Phase @ 230v Based On **kW** Electrical Load	126.0
Approxomate Fuel Consumption @ Prime Power	9.3

4 - Pole (1500rpm) 50Hz 380/400/415v - 3 Phase	ECP32-3S/4
Maximum AC Output - 50Hz 3 Phase @ 1500 rpm - **kVA**	42.0
Prime AC Output - 50Hz 3 Phase @ 1500 rpm **0.8PF - kVA**	38.2
Typical Maximum Load In Amps Per Phase @ 415v Based On **kW** Electrical Load	43.0
Approxomate Fuel Consumption @ Prime Power	9.2

4 - Pole (1800rpm) 60Hz 120v - 1 Phase	ECP32-2M/4
Maximum AC Output - 60Hz 1 Phase @ 1800 rpm - **kVA**	42.9
Prime AC Output - 60Hz 1 Phase @ 1800 rpm **0.8PF - kVA**	39.0
Typical Maximum Load In Amps Per Phase @ 120v Based On **kW** Electrical Load	260.0
Approxomate Fuel Consumption @ Prime Power	9.9

4 - Pole (1800rpm) 60Hz 208v - 3 Phase	ECP32-3S/4
Maximum AC Output - 60Hz 3 Phase @ 1800 rpm - **kVA**	46.2
Prime AC Output - 60Hz 3 Phase @ 1800 rpm **0.8PF - kVA**	42.0
Typical Maximum Load In Amps Per Phase @ 208v Based On **kW** Electrical Load	95.0
Approxomate Fuel Consumption @ Prime Power	10.1

Approximate Nett Dry Weight	40T IIIA
BetaSet - **Kg (lbs)**	454
BetaGen - **Kg (lbs)**	580

49	49T IIIA
✓	✓
✓	✓

ECP32-3L/4	ECP32-3L/4
42.5	45.0
38.6	40.9
134.0	142.0
9.2	10.4

ECP32-2M/4	ECP32-2M/4
45.0	48.0
40.9	43.6
47.0	49.0
9.2	10.3

ECP32-3L/4	ECP32-3L/4
49.5	52.8
45.0	48.0
300.0	320.0
10.5	11.8

ECP32-2M/4	ECP32-2M/4
53.4	58.0
50.0	52.7
113.0	119.0
10.6	12.3

49	49T IIIA
602	735
792	950

2 - Pole Technical Specifications

BetaSet-BetaGen	4/2
Kubota/Beta Marine 4 - Cycle Base Engine	BZ482
Cylinders - No. In-line	2
Naturally Aspirated	✓
Turbocharged	-
After Treatment - Exhaust Gas Recirculation	-
Combustion Chamber - E TVCS Indirect Injection	✓
Combustion Chamber - E-CDIS Direct Injection	-
Fuel Injection Pressure - **kgf/cm² (psi)**	140 (1991)
Fuel Injection Pump - In-Line	✓
Fuel Injection Timing BTDC - **°/rpm (°/rpm)**	20.0°/3000 (22.0°/3600)
Fuel - Diesel Fuel Oil To EN590 Or ASTM D975	✓
Engine Governor	All Speed Mechanical
Bore & Stroke - **mm (cu.in)**	67.0 x 68.0 (2.64 x 2.68)
Compression Ratio	23.5
Displacement - **cc (cu in)**	479 (29.23)
Engine Maximum Output - **HP/rpm (HP/rpm)**	11.0/3000 (13.0/3600)
Engine Maximum Output - **kW/rpm (kW/rpm)**	8.2/3000 (9.7/3600)
Engine Prime Output - **HP/rpm (HP/rpm)**	10.0/3000 (11.8/3600)
Engine Prime Output - **kW/rpm (kW/rpm)**	7.5/3000 (8.8/3600)
Starting Aid	Glow Plug
Firing Order	1-2
Valve Tip Clearance (Cold) - **mm (in)**	0.145 - 0.185 (0.0057 - 0.0072)
Direction of Rotation - Counter Clockwise (Viewed From The Flywheel)	✓
Lubricating Oil System - Forced By Trochoid Pump	✓
Lubricating Oil Pressure At Rated RPM - **kgf/cm² (psi)**	2.0 - 4.4 (28.5 - 64.0)
Lubricating Oil Capacity Of Standard Sump - **L (U.S gal)**	2.1 (0.56)
Lubricating Oil SAE - **Ambient Temperatures Change Requirement, refer to:**	Page 50
Engine Closed Circuit Coolant Circulation - Pressurised, Forced By Water Pump	✓
Engine Closed Circuit Coolant Capacity - Heat Exchanger Engines - **L (U.S gal)**	2.25 (0.6)
Engine Closed Circuit Coolant - Anti-freeze Mixed 30% > 50% With Water, refer to:	Page 46
Electric Start - 12 Volt Grounded Earth	✓
Electric Start - 12 Volt Insulated Return & 70 Amp Alternator	Opt.
Electric Start - 24 Volt Insulated Return & 55 Amp Alternator	Opt.
Min. Recommended Battery Capacity	70Ah 450CCA

6/2	11/2	22/2
BZ482	BD772	BV1505
2	3	4
✓	✓	✓
-	-	-
-	-	-
✓	✓	✓
-	-	-
140 (1991)	140 (1991)	140 (1991)
✓	✓	✓
20.0°/3000 (22.0°/3600)	20.0°/3000 (22.0°/3600)	20.0°/3000 (17.0°/3600)
✓	✓	✓
All Speed Mechanical	All Speed Mechanical	All Speed Mechanical
67.0 x 68.0 (2.64 x 2.68)	67.0 x 68.0 (2.64 x 2.68)	78.0 x 78.4 (3.07 x 3.09)
23.5	23.5	24.0
479 (29.23)	719 (43.88)	1498 (91.41)
11.0/3000 (13.0/3600)	16.5/3000 (19.6/3600)	34.8/3000 (36.2/3600)
8.2/3000 (9.7/3600)	12.3/3000 (14.6/3600)	26.0/3000 (27.3/3600)
10.0/3000 (11.8/3600)	15.0/3000 (17.8/3600)	31.8/3000 (32.9/3600)
7.5/3000 (8.8/3600)	11.2/3000 (13.3/3600)	23.7/3000 (24.5/3600)
Glow Plug	Glow Plug	Glow Plug
1-2	1-2-3	1-3-4-2
0.145 - 0.185 (0.0057 - 0.0072)	0.145 - 0.185 (0.0057 - 0.0072)	0.145 - 0.185 (0.0057 - 0.0072)
✓	✓	✓
✓	✓	✓
2.0 - 4.5 (28.0 - 64.0)	2.0 - 4.5 (28.0 - 64.0)	2.0 - 4.5 (28.0 - 64.0)
2.5 (0.66)	3.8 (1.6)	6.7 (1.8)
Page 50	Page 50	Page 50
✓	✓	✓
7.0 (1.85)	7.0 (1.85)	7.0 (1.85)
Page 46	Page 46	Page 46
✓	✓	✓
Opt.	Opt.	Opt.
Opt.	Opt.	Opt.
70Ah 450CCA	70Ah 450CCA	70Ah 450CCA

BetaSet-BetaGen	4/2
AC Alternator Mecc Alte, Brushless, Single Bearing With IP 22 Protection	✓
Digitally Controlled, Adjustable, Automatic Voltage Regulator	✓

2 - Pole (3000rpm) 50Hz 220/230/240v - 1 Phase	S16F-180
Maximum AC Output - 50Hz 1 Phase @ 3000 rpm - **kVA**	4.0*
Prime AC Output - 50Hz 1 Phase @ 3000 rpm **0.8PF - kVA**	3.6*
Typical Maximum Load In Amps Per Phase @ 230v Based On **kW** Electrical Load	16.0
Approxomate Fuel Consumption @ Prime Power	1.4

2 - Pole (3000rpm) 50Hz 380/400/415v - 3 Phase	-
Maximum AC Output - 50Hz 3 Phase @ 3000 rpm - **kVA**	-
Prime AC Output - 50Hz 3 Phase @ 3000 rpm **0.8PF - kVA**	-
Typical Maximum Load In Amps Per Phase @ 415v Based On **kW** Electrical Load	-
Approxomate Fuel Consumption @ Prime Power	-

2 - Pole (3600rpm) 60Hz 120v - 1 Phase	S16F-180
Maximum AC Output - 60Hz 1 Phase @ 3600 rpm - **kVA**	4.5*
Prime AC Output - 60Hz 1 Phase @ 3600 rpm **0.8PF - kVA**	4.1*
Typical Maximum Load In Amps Per Phase @ 120v Based On **kW** Electrical Load	34.0
Approxomate Fuel Consumption @ Prime Power	1.7

2 - Pole (3600rpm) 60Hz 208v - 3 Phase	-
Maximum AC Output - 60Hz 3 Phase @ 3600 rpm - **kVA**	-
Prime AC Output - 60Hz 3 Phase @ 3600 rpm **0.8PF - kVA**	-
Typical Maximum Load In Amps Per Phase @ 208v Based On **kW** Electrical Load	-
Approxomate Fuel Consumption @ Prime Power	-

Approximate Nett Dry Weight	4/2
BetaSet - **Kg (lbs)**	116 (256)
BetaGen - **Kg (lbs)**	160 (353)

The BetaSet-BetaGen 4/2 & 6/2 are unity power factor.

6/2	11/2	22/2
✓	✓	✓
✓	✓	✓

S16F-180	ECP28-M/2	ECP28-2L/2
6.5*	12.2	16.5
5.9*	11.1	15.0
26.0	39.0	52.0
2.3	3.5	4.5

-	ECP28-M/2	ECP28-2L/2
-	13.7	23.1
-	12.5	21.0
-	14.0	23.0
-	3.6	5.9

S16F-180	ECP28-M/2	ECP28-2L/2
7.7*	14.0	17.0
7.0*	12.7	15.4
58.0	85.0	103.0
2.9	4.2	4.8

-	ECP28-M/2	ECP28-2L/2
-	15.0	24.0
-	13.6	21.8
-	31.0	48.0
-	4.3	6.4

6/2	11/2	22/2
116 (256)	225 (496)	286 (630)
160 (353)	286 (630)	380 (838)

BetaSet-BetaGen	25/2
Kubota/Beta Marine 4 - Cycle Base Engine	BV1505
Cylinders - No. In-line	4
Naturally Aspirated	✓
Turbocharged	-
After Treatment - Exhaust Gas Recirculation	-
Combustion Chamber - E TVCS Indirect Injection	✓
Combustion Chamber - E-CDIS Direct Injection	-
Fuel Injection Pressure - **kgf/cm² (psi)**	140 (1991)
Fuel Injection Pump - In-Line	✓
Fuel Injection Timing BTDC - **°/rpm (°/rpm)**	18.0°/3000 (20.0°/3600)
Fuel - Diesel Fuel Oil To EN590 Or ASTM D975	✓
Engine Governor	All Speed Mechanical
Bore & Stroke - **mm (cu.in)**	78.0 x 78.4 (3.07 x 3.09)
Compression Ratio	23.0
Displacement - **cc (cu in)**	1498 (91.41)
Engine Maximum Output - **HP/rpm (HP/rpm)**	34.8/3000 (36.2/3600)
Engine Maximum Output - **kW/rpm (kW/rpm)**	26.0/3000 (27.0/3600)
Engine Prime Output - **HP/rpm (HP/rpm)**	31.8/3000 (32.9/3600)
Engine Prime Output - **kW/rpm (kW/rpm)**	23.7/3000 (24.5/3600)
Starting Aid	Glow Plug
Firing Order	1-3-4-2
Valve Tip Clearance (Cold) - **mm (in)**	0.145 - 0.185 (0.0057 - 0.0072)
Direction of Rotation - Counter Clockwise (Viewed From The Flywheel)	✓
Lubricating Oil System - Forced By Trochoid Pump	✓
Lubricating Oil Pressure At Rated RPM - **kgf/cm² (psi)**	2.0 - 4.4 (28.5 - 64.0)
Lubricating Oil Capacity Of Standard Sump - **L (U.S gal)**	6.7 (1.8)
Lubricating Oil SAE - **Ambient Temperatures Change Requirement, refer to:**	Page 50
Engine Closed Circuit Coolant Circulation - Pressurised, Forced By Water Pump	✓
Engine Closed Circuit Coolant Capacity - Heat Exchanger Engines - **L (U.S gal)**	7.0 (1.85)
Engine Closed Circuit Coolant - Anti-freeze Mixed 30% > 50% With Water, refer to:	Page 46
Electric Start - 12 Volt Grounded Earth	✓
Electric Start - 12 Volt Insulated Return & 70 Amp Alternator	Opt.
Electric Start - 24 Volt Insulated Return & 55 Amp Alternator	Opt.
Min. Recommended Battery Capacity	70Ah 450CCA

BetaSet-BetaGen	25/2
AC Alternator Mecc Alte, Brushless, Single Bearing With IP 22 Protection	✓
Digitally Controlled, Adjustable, Automatic Voltage Regulator	✓

2 - Pole (3000rpm) 50Hz 220/230/240v - 1 Phase	ECP28-VL/2
Maximum AC Output - 50Hz 1 Phase @ 3000 rpm - **kVA**	25.5
Prime AC Output - 50Hz 1 Phase @ 3000 rpm **0.8PF - kVA**	23.2
Typical Maximum Load In Amps Per Phase @ 230v Based On **kW** Electrical Load	81.0
Approxomate Fuel Consumption @ Prime Power	6.8

2 - Pole (3000rpm) 50Hz 380/400/415v - 3 Phase	ECP28-VL/2
Maximum AC Output - 50Hz 3 Phase @ 3000 rpm - **kVA**	28.0
Prime AC Output - 50Hz 3 Phase @ 3000 rpm **0.8PF - kVA**	25.5
Typical Maximum Load In Amps Per Phase @ 415v Based On **kW** Electrical Load	28.0
Approxomate Fuel Consumption @ Prime Power	7.1

2 - Pole (3600rpm) 60Hz 120v - 1 Phase	ECP28-VL/2
Maximum AC Output - 60Hz 1 Phase @ 3600 rpm - **kVA**	25.5
Prime AC Output - 60Hz 1 Phase @ 3600 rpm **0.8PF - kVA**	23.1
Typical Maximum Load In Amps Per Phase @ 120v Based On **kW** Electrical Load	154.0
Approxomate Fuel Consumption @ Prime Power	7.2

2 - Pole (3600rpm) 60Hz 208v - 3 Phase	ECP28-VL/2
Maximum AC Output - 60Hz 3 Phase @ 3600 rpm - **kVA**	32.0
Prime AC Output - 60Hz 3 Phase @ 3600 rpm **0.8PF - kVA**	27.2
Typical Maximum Load In Amps Per Phase @ 208v Based On **kW** Electrical Load	61.0
Approxomate Fuel Consumption @ Prime Power	8.4

Approximate Nett Dry Weight	25/2
BetaSet - **Kg (lbs)**	296 (657)
BetaGen - **Kg (lbs)**	390 (860)

Section 1: Installation Guidelines

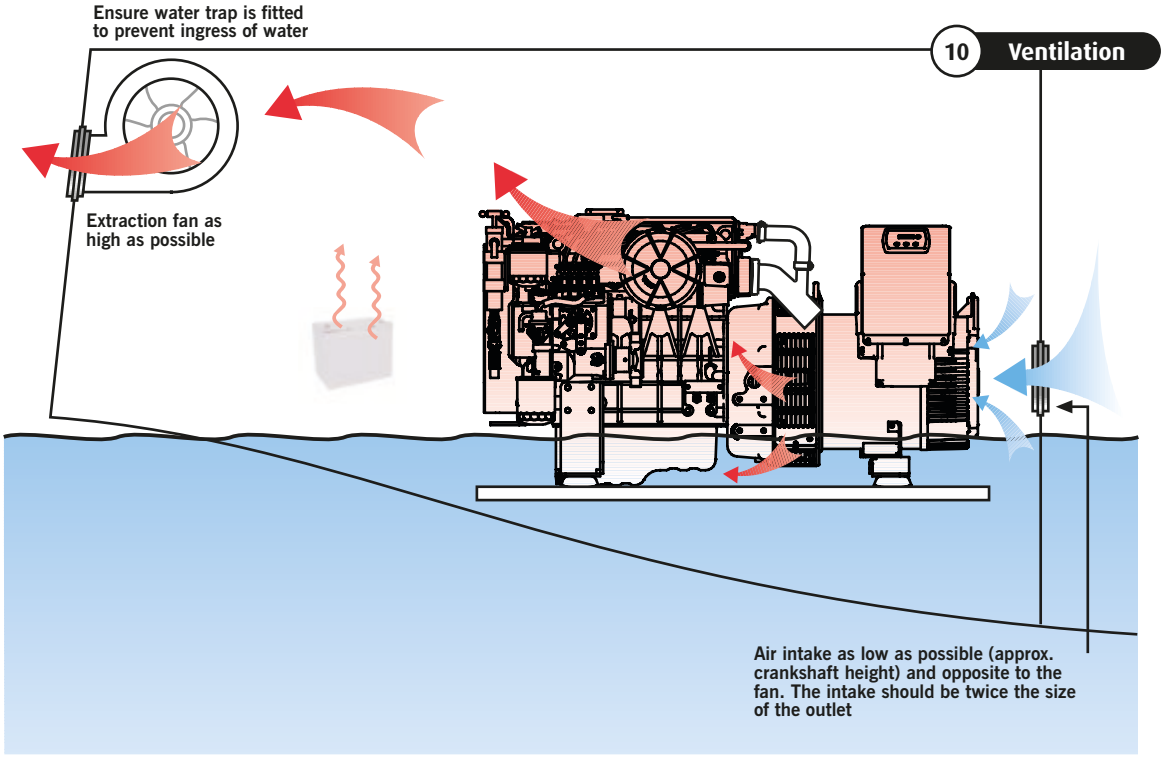
INSTALLATION RECOMMENDATIONS

The installation details are basic guidelines to assist installation, however due to the great diversity of marine craft it is unrealistic to give definitive instructions.

Therefore Beta Marine can accept no responsibility for any damage or injury incurred during the installation of a Beta Marine generating set whilst following these guidelines.

- All generating sets should be placed within an enclosure separated from living quarters and installed so as to minimise the risk of fires or spread of fires as well as hazards from toxic fumes, heat, noise or vibrations in the living quarters.
- Unless the generating set is protected by a cover or its own enclosure, exposed moving or hot parts of the engine that could cause personal injury should be effectively shielded.
- Engine parts and accessories that require frequent inspection and/or servicing must be readily accessible.
- The insulating materials inside engine spaces shall be non-combustible.

VENTILATION



⚠ IMPORTANT!

BetaGen Variants - Natural ventilation to the acoustic enclosure must be provided.

It is recommended that the inlet and outlet areas for the ventilation are $^1/_3$ greater than the inlet and outlet areas built into the acoustic enclosure. If this is not the case forced ventilation should be considered but not connected directly to the acoustic enclosure.

An engine will produce radiated heat - approximately equal to $^1/_3$ of the engine output power. Additionally, the starter battery alternator and generating set AC alternator create heat, building ambient temperatures further.

As a consequence, it is highly important and the vessels owner and/or installation engineer/s are responsible to ensure that the engine compartment has adequate ventilation to enable efficient internal combustion, effective transference of heat out of the engine compartment/room and prevent the accumulation of gases, which might be emitted from starter batteries.

Best practice for efficient and effective ventilation is an air intake that is located in the engine compartment/ room that is as low as possible, allowing cooler air to enter below the generating set engine and AC electrical alternator and an air outlet with an electric powered extraction fan which should be located as high as possible in the engine compartment/room maximising ventilation and reducing ambient temperatures.

The cooler the engine compartment/room can be maintained the more efficient the engine will perform.

COMBUSTION AIR REQUIREMENTS

4 Pole 50 Hz - 1,500 RPM

BetaSet-BetaGen	7	10	12	14	21	26	33	40 & 49	40T & 49T IIIA
m3/min	0.50	0.73	0.98	1.08	1.43	2.16	2.16	2.46	3.60
m3/hr	34.88	43.94	58.57	64.54	85.95	129.84	129.84	147.58	159.00

2 Pole 50 Hz - 3,000 RPM

BetaSet-BetaGen	4/2	6/2	11/2	22/2	25/2
m3/min	0.59	0.59	0.59	0.93	1.95
m3/hr	35.36	35.36	55.94	117.00	117.00

4 Pole 60 Hz - 1,800 RPM

BetaSet-BetaGen	7	10	12	14	21	26	33	40 & 49	40T & 49T IIIA
m3/min	0.82	0.88	1.17	1.29	1.72	2.60	2.60	2.95	2.95
m3/hr	49.32	52.73	70.28	77.45	103.15	155.81	155.81	177.10	191.00

2 Pole 60 Hz - 3,600 RPM

BetaSet-BetaGen	4/2	6/2	11/2	22/2	25/2
m3/min	0.71	0.71	1.12	1.12	1.12
m3/hr	42.44	42.44	67.13	140.40	140.40

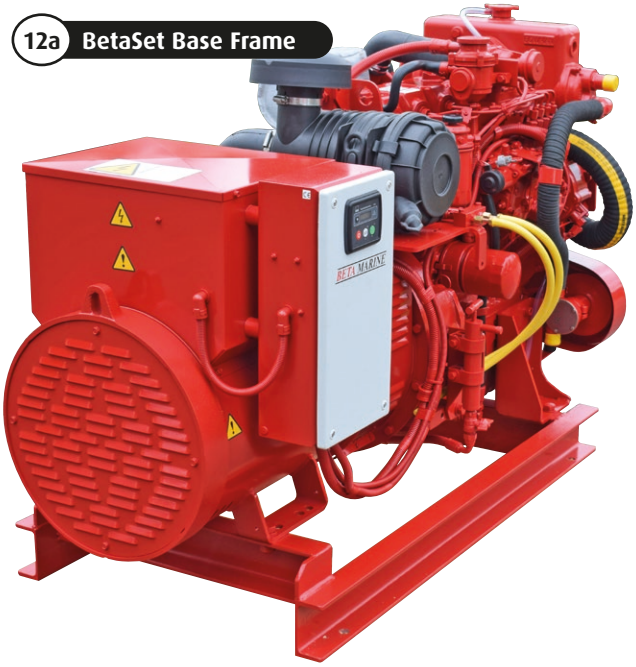
GENERATING SET MOUNTING

All generating sets must be mounted on Anti-Vibration Mountings (AVM) at some point between the engine feet and the vessels seating.

IMPORTANT!

Keep flexible mounts free from diesel fuel, engine coolant & lubrication oil to prevent deterioration.

11 Anti-Vibration Mount (AVM)



12a BetaSet Base Frame

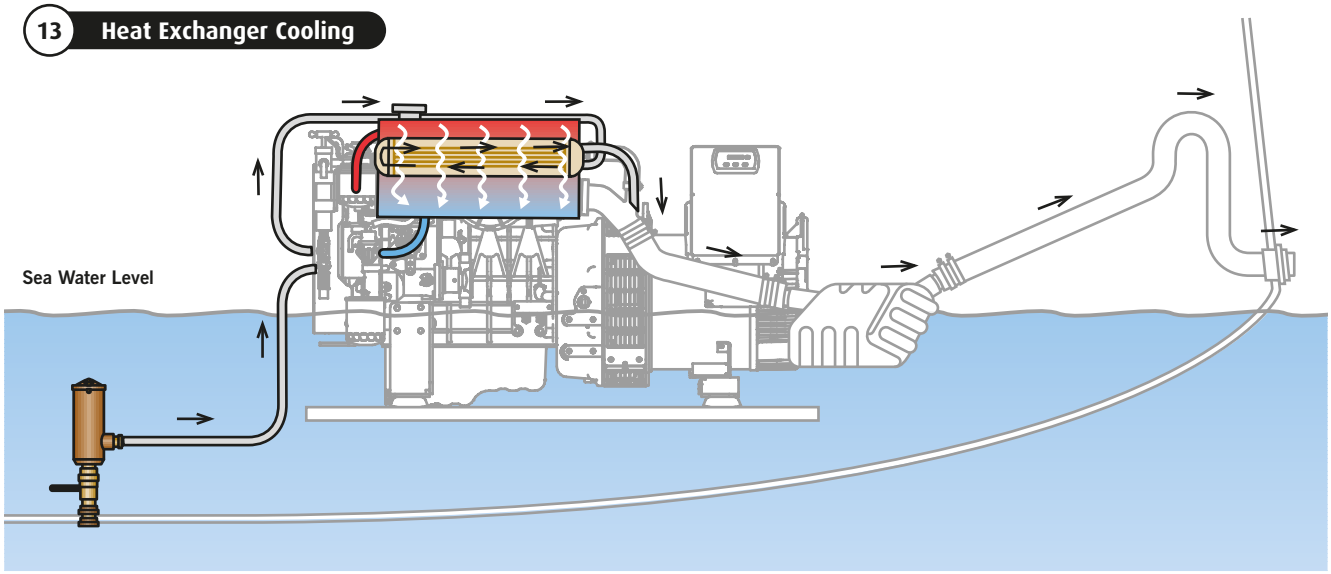
12b BetaGen Acoustic Housing

IMPORTANT!

- **The seating in the vessel should be level in all planes so that the generating set can be bolted down without stress or distortion.**
- **On open BetaSets (image 11) the anti-vibration mounts will bolt directly to the vessels seating. Shim between the underside of the mount and vessels seating so that each mount is equally compressed. It is important that the vessels seating is substantial and rigid otherwise the efficiency of the anti-vibration mountings will be compromised.**
- **On open BetaSets with base frames (image 12a) depending on installation requirements, the anti-vibration mounts may be positioned either between the generating set feet and base frame or between the vessels seating and base frame should the generating set be rigidly bolted to the base frame.**
- **On enclosed BetaGens (image 12b) the anti-vibration mounts are mounted between the generating set and the acoustic housing frame which in turn is then secured directly to the vessels seating via the housing base.**

GENERATING SETS WITH HEAT EXCHANGER COOLING

13 Heat Exchanger Cooling



Heat Exchanger cooling takes in sea water through the bottom of the hull via a seacock with a strainer, to the seawater pump mounted on the engine. The seawater is pumped through piping on to the heat exchanger where it passes through the cupronickel 'tubestack'; first though the bottom pipes, then back through the top pipes before exiting via the exhaust injection bend. From the injection bend the seawater falls into the waterlock and is then blown by the engine exhaust through a 'gooseneck' and out of the stern of the boat. The engine cooling has a closed circuit that uses a coolant solution of 30 > 50% Anti-freeze and 70 < 50% fresh water. This coolant circulates round the engine collecting heat and transfers the heat to the seawater in the heat exchanger as it circulates around the outside of the cupronickel 'tubestack' pipes.

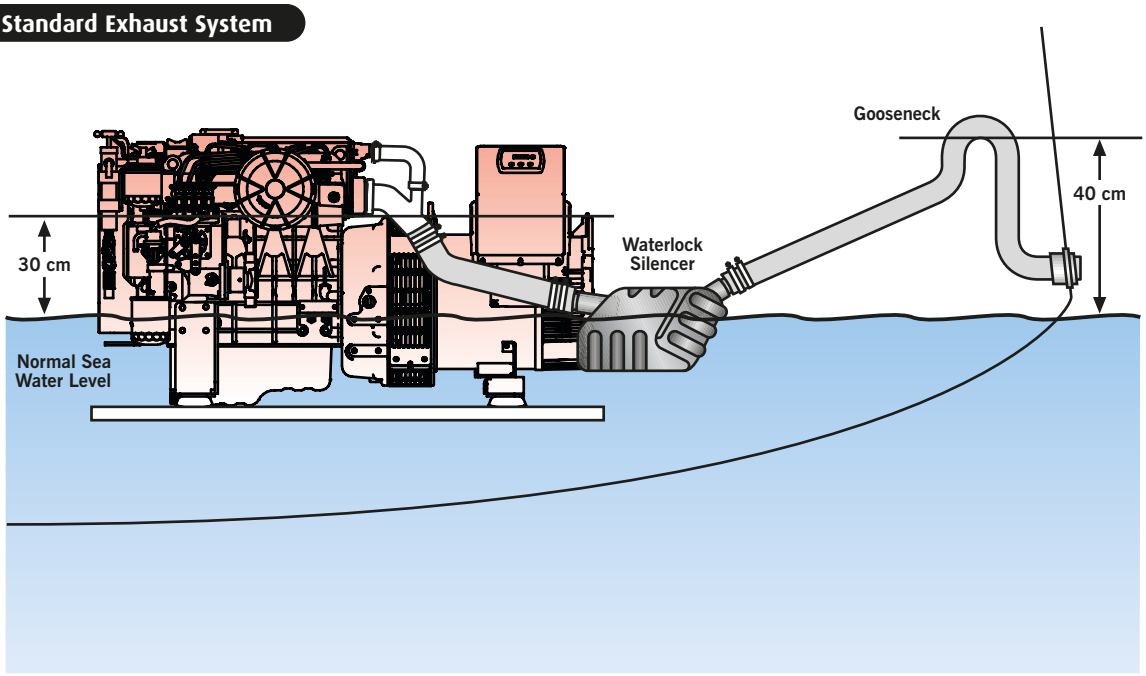
HEAT EXCHANGER COOLING - WET EXHAUSTS

Three major problems that can easily occur when installing a generating set in a vessel which need to be managed to ensure the generating set engine is not subjected to any possible 'hydraulic lock'. This occurs when water is allowed to enter the combustion chamber and 'hydraulics' against the rising piston with the consequences possibly being, a bent con rod/s, an emulsified engine oil and/or a damaged fuel pump.

- Seawater syphoning past worn impellers in the seawater pump, flooding the exhaust system, and back filling into the combustion chamber when the engine is stopped.
- Seawater washing into the combustion chamber from the exhaust system due to either a very shallow exhaust run from the injection bend to the waterlock silencer, or because the waterlock silencer is too small to accept the total amount of cooling water in the exhaust hoses, or both. This can happen when the vessel is sailing into a big sea and a surge is set up in exhaust system as the vessel pitches - with the engine switched off.
- Waves forcing water up the exhaust due a poorly designed system with no 'gooseneck'. Small work boats moored on exposed beaches are very vulnerable to this as waves hit the stern before the boat can swing into the wind on a rising tide.

If the engine is installed below the water line, the potential for water entering the engine is considerably increased. The important dimension that must be measured is from the normal 'static' sea level to the point at where the cooling water is injected into the exhaust - this should be a minimum of 30 cms. If this can not be achieved the following options must be taken. Please refer to images 14, 15 & 16.

14 **Standard Exhaust System**

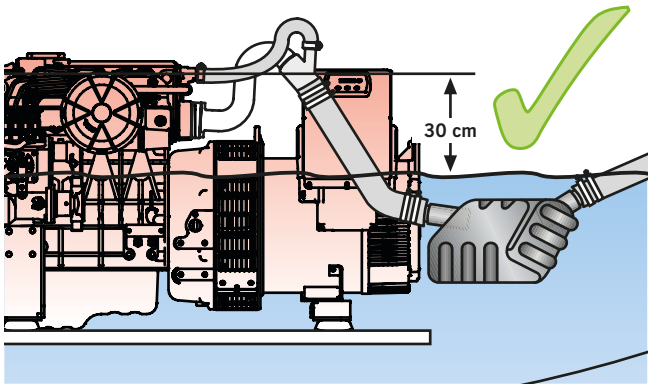


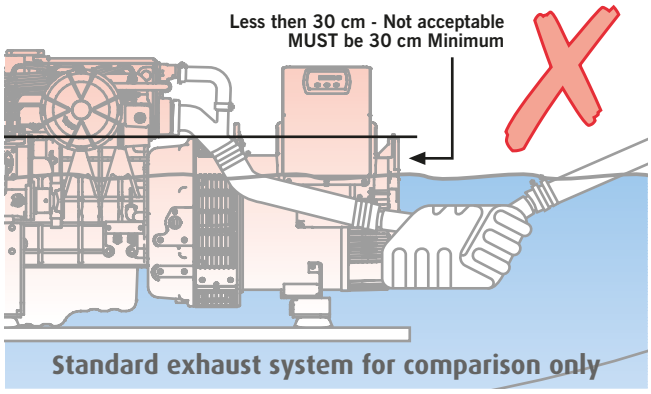
HIGH-RISE EXHAUST

If the standard injection bend is too low then Beta Marine offer high-rise injection bends that may add either 15 cms or 20 cms to the height.

If it is still not enough then an 'antisyphon'/vacuum valve must be fitted 50 cms above the 'loaded' water line sea level. Please refer to image 16.

15 **Exhaust with High Rise**





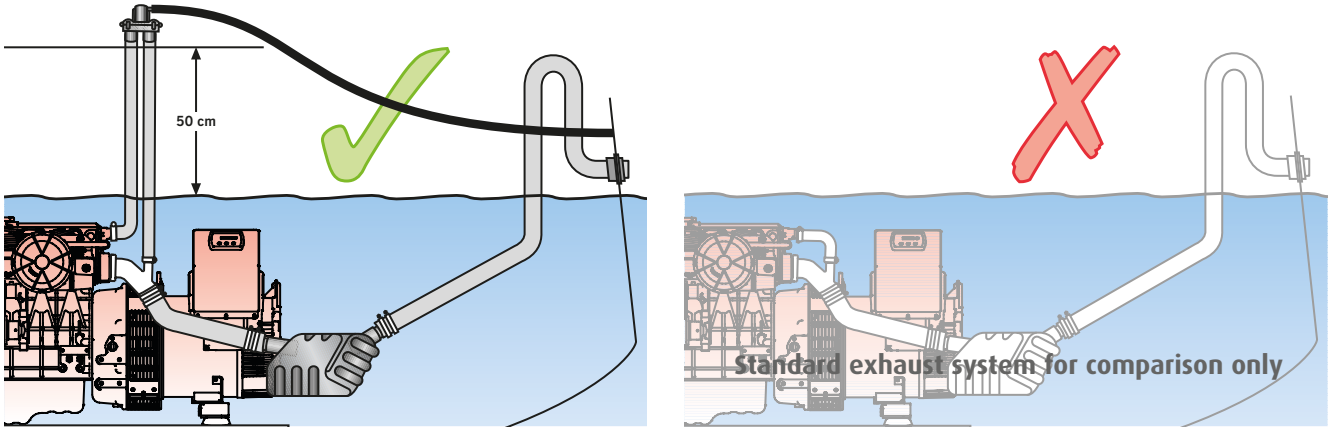
EXHAUST WITH ANTI-SYPHON VALVE

When fitting an anti-syphon valve to a vessel, it must be mounted as near as possible to the centerline so that there is no possibility that the valve goes under the water line when the yacht heels over.

IMPORTANT!

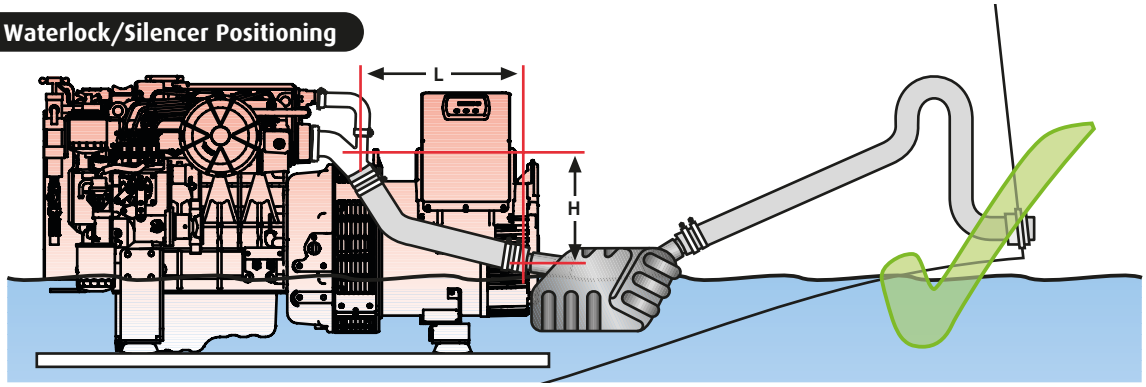
Anti-syphon valves need to be checked regularly as they can be accustomed to block up with salt crystals over time.

16 Exhaust with Anti-syphon Valve



WATERLOCK/SILENCER

17 Waterlock/Silencer Positioning



Always fit a waterlock/silencer to stop any water in the exhaust system back filling the engine. The water lock should always be fitted at least 30 cms away from the injection bend and at least 30 cms below the injection bend, being as low as practically possible, so that all the water can drain down into it. The waterlock should have sufficient capacity to hold an exhaust system full of water - draining into it.

Always create a 'gooseneck' with the exhaust hose (or purchase a propriety one) by raising the exhaust hose 40 cms above the waterline before exiting the transom at least 5 cms above the waterline. This will stop any waves pushing seawater down the exhaust.

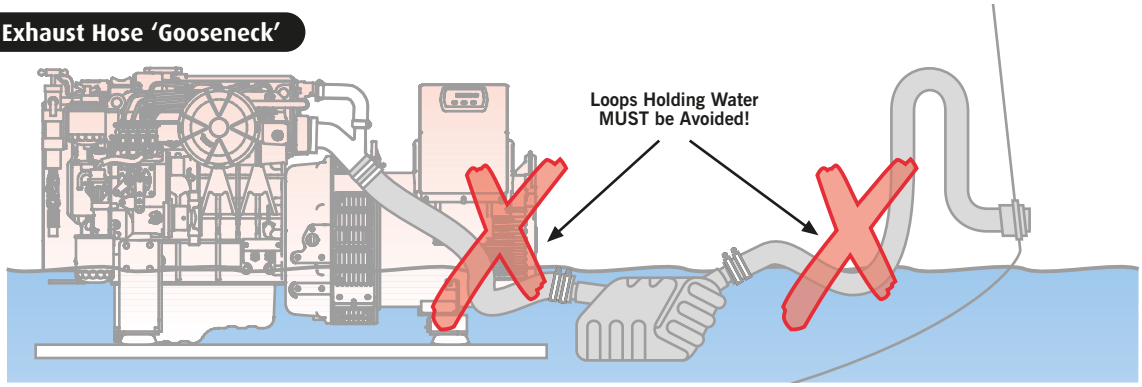
Position of silencer in relation to exhaust hose length:

Length (L)	Height (H)
30 cm	30 cm
120 cm	40 cm

IMPORTANT!

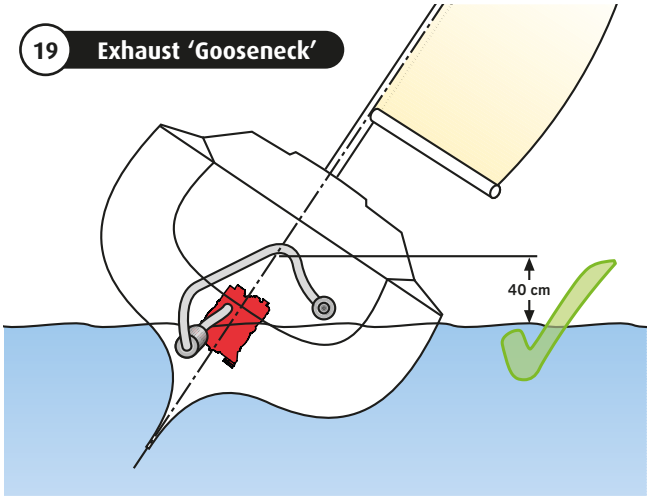
If measurement 'H' cannot be met, a high rise exhaust injection bend must be installed so that any residual water flows/drains into the waterlock/silencer or overboard.

18 Exhaust Hose 'Gooseneck'



With longer lengths of exhaust hose you may need to support the hose to avoid a drooping hose and water build up.

19 Exhaust 'Gooseneck'



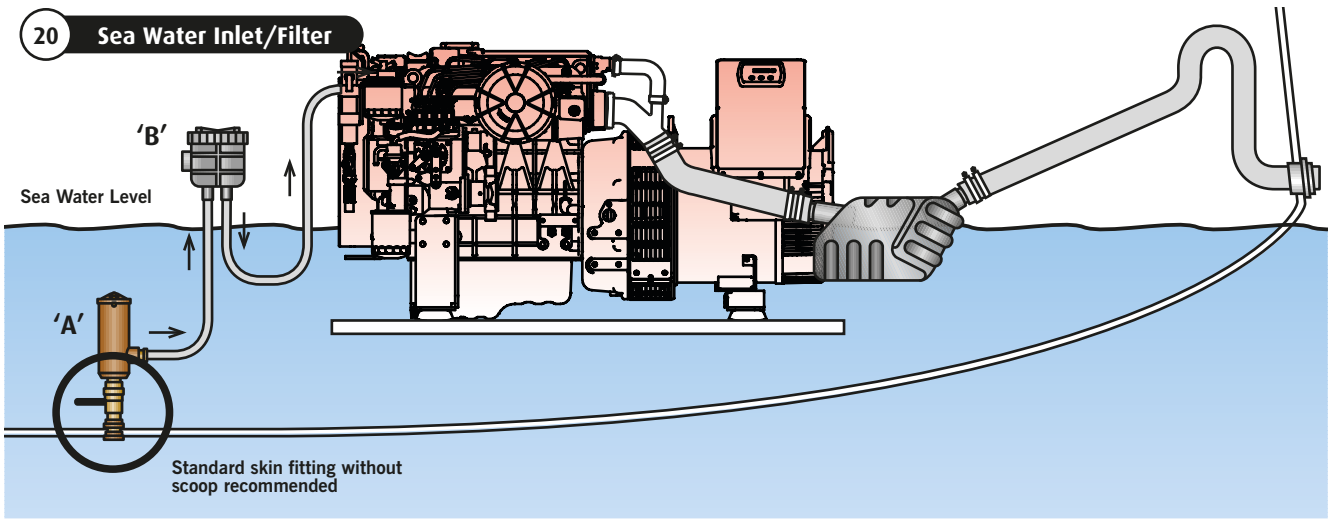
SEA WATER INLET FOR HEAT EXCHANGER COOLED ENGINES

Beta Marine engines are fitted with a gear driven sea water pump which sucks in seawater (raw water) to cool the closed circuit system via the heat exchanger.

1. It is very important that the seawater inlet should have a strainer system either **'A'** built into the sea cock, or **'B'** a high level system with visual inspection glass (please refer to image 20) mounted just above the water line.

BetaSet-BetaGen	Seacock Inlet/Seawater Pump Hose I.D
7, 10, 12, 4/2, 6/2, 11/2, 22/2 & 25/2	Min. 19 mm
14 & 21	Min. 25 mm
26, 33, 40, 49, 40T IIIA & 49T IIIA	Min. 32 mm

20 Sea Water Inlet/Filter



2. Good access to the inlet sea cock from inside your boat is essential so that debris or seaweed trapped in the intake can be removed.
3. All pipe work should have approved marine grade stainless steel hose clips. Any loose clamps or bad connections can cause flooding and sinking of the vessel. It is accepted practice that two stainless steel clips should be used at each end of raw water pipes for security. Ensure that you use the correct grade of hose.

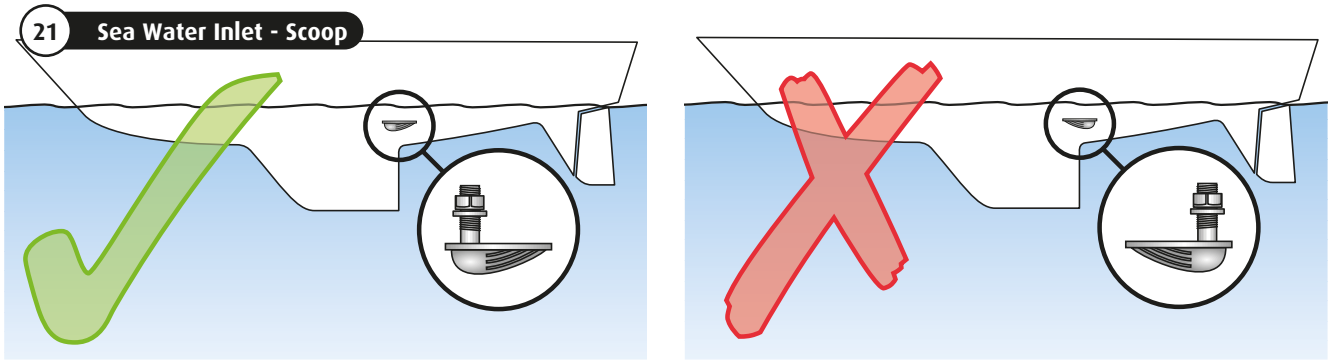
NB:

- The maximum lift of the sea water pump is 2m when primed.
- The water intake hose must be a reinforced type so that it does not collapse under suction.

4. A normal inlet sea cock type **'A'** is recommended as this can be 'rodded out' to remove blockages, please refer to image 20.

   We do not recommend the use of 'scoop' type water pickups, because if fitted the wrong way around the water will be forced through the pump and into the exhaust system whilst the vessel is sailing. This is very dangerous as the exhaust will eventually fill and sea/raw water will back up into the engine through the exhaust valve. Catastrophic failure will result as soon as the engine is restarted. Please refer to image 21.

21 Sea Water Inlet - Scoop



EXHAUST HOSE

Wet exhaust hose should be matched to the injection bend diameter. An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (Recreational Craft Directive).

BetaSet-BetaGen	Hose I.D
4/2, 6/2, 11/2, 22/2, 25/2, 7, 10, 12, 14 & 21	50 mm
26, 33, 40 & 49	60 mm
40T IIIA & 49T IIIA	90 mm

EXHAUST BACK PRESSURE

Exhaust back pressure should be as low as possible; it is increased by long exhaust length and sharp bends. Keep exhaust systems to a minimum length and have gradual bends avoid tight angled elbows. Back pressure should be measured with the complete exhaust system connected and the generating set running at service speed. The correct measuring point is before the injection bend (at the manifold flange).

BetaSet-BetaGen	Exhaust Back Pressure
4/2, 6/2 & 11/2	Max. 70 mm Hg
7, 10, 12, 14, 21, 22/2 & 25/2	Max. 80 mm Hg
26, 33, 40 & 49	Max. 90 mm Hg
40T IIIA & 49T IIIA	85 to 115 mm Hg

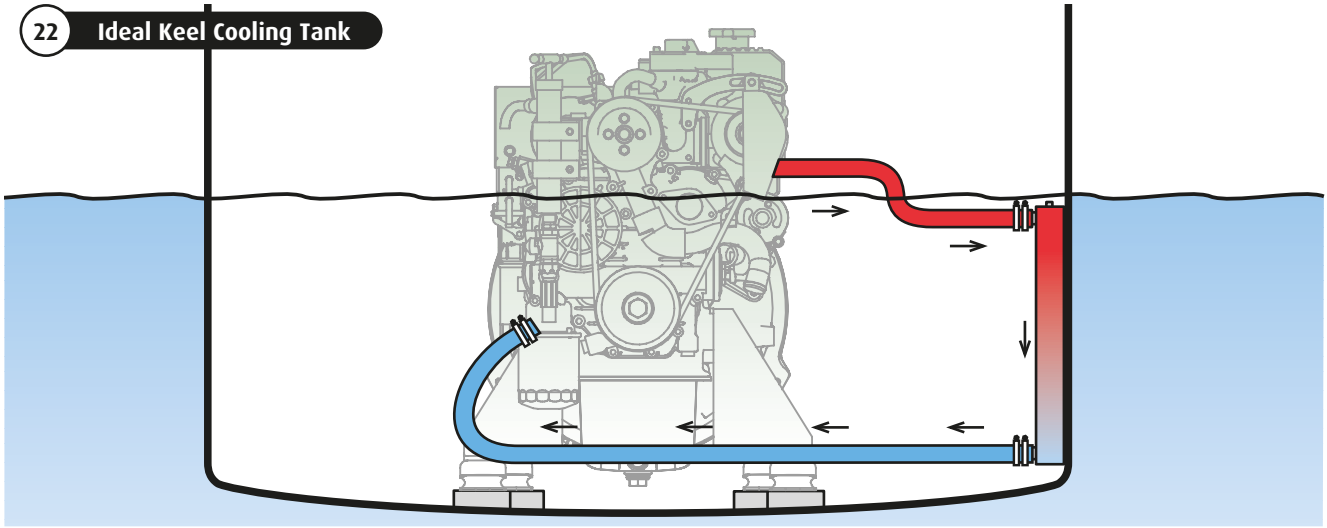
GENERATING SETS WITH KEEL COOLING

Keel Cooling is often used on steel work boats, fishing boats and inland waterway boats where a grid cooler or heat transfer tank are built into the hull to give a closed circuit system. In these applications no seawater pump is used as the engine circulating pump pushes the water/ anti-freeze solution around the closed system.

KEEL COOLING - SKIN TANKS

Keel cooling 'skin' tanks are normally welded into the 'swim' of the vessel, please refer to image 22 & 23. They use the hulls' 8mm steel plate as one side of the keel cooling tank that transfers the engine heat into the canal, river or sea water. The larger the engine/horse power the larger the 'skin' tank surface area that is required for keel cooling engines. Keel cooling pipes under the hull of vessels that achieve the same surface area can also be used. Generally the keel cooling tank should have a surface area that is exposed to the canal, river or sea water of: **0.25 x the hp of the engine = the square feet of cooling tank area required (for steel hulls).**

22 Ideal Keel Cooling Tank



BetaSet-BetaGen	7	10	12	14	21	26	33	40 & 49	40T & 49T IIIA
Steel Tanks (Ft^2)	2.50	3.50	4.50	5.50	7.50	9.50	12.0	16.50	16.50
Steel Tanks (M^2)	0.23	0.30	0.39	0.47	0.62	0.87	0.87	1.37	1.37
Dry Exhaust Stub (BSP)	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	2"

BetaSet-BetaGen	4/2	6/2	11/2	22/2	25/2
Steel Tanks (Ft^2)	3.00	3.00	4.50	8.50	8.50
Steel Tanks (M^2)	0.25	0.25	0.37	0.75	0.75
Dry Exhaust Stub (BSP)	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"	$1^1/_2$"

The ideal keel cooling tank should have:

a) The most efficient keel cooling tank/s are hull side mounted, please refer to image 22 & 23.

b) The rubber hoses connecting the engine to the keel cooling tanks should be designed and manufactured as hot water heater hoses suitable for operation up to 100°C.

c) The 'baffle' must be continuously welded to the outer skin and to one end as shown, and should be as close as posisble to the inner skin.

d) The tank should be thin in section (C = 30 mm to 40 mm) as it is the most efficient heat transfer to the canal, river or sea water that is important.

e) The engine coolant for keel cooling (is the same 50:50 ratio of fresh water/anti-freeze solution* as heat exchanger cooling) and flows around the engine, then the keel cooling tanks, before returning to the engine.

f) The keel cooling tank must have air bleed valves fitted on the top at both ends of the tank.

g) The hot water feed enters at the top of the tank and the colder engine return comes out of the bottom.

*Please refer to 'Technical Specifications' on pages 12 to 29.

BetaSet-BetaGen	7	10	12	14	21	26	33	40 & 49	40T & 49T IIIA
Supply & Return Pipe	28mm	28mm	28mm	28mm	28mm	32mm	32mm	32mm	32mm
Baffle Gap Minimum	30mm	30mm	30mm	30mm	30mm	30mm	30mm	30mm	30mm
Baffle Gap Maximum	40mm	40mm	40mm	40mm	40mm	40mm	40mm	40mm	40mm

BetaSet-BetaGen	4/2	6/2	11/2	22/2	25/2
Supply & Return Pipe	28mm	28mm	28mm	28mm	28mm
Baffle Gap Minimum	30mm	30mm	30mm	30mm	30mm
Baffle Gap Maximum	40mm	40mm	40mm	40mm	40mm

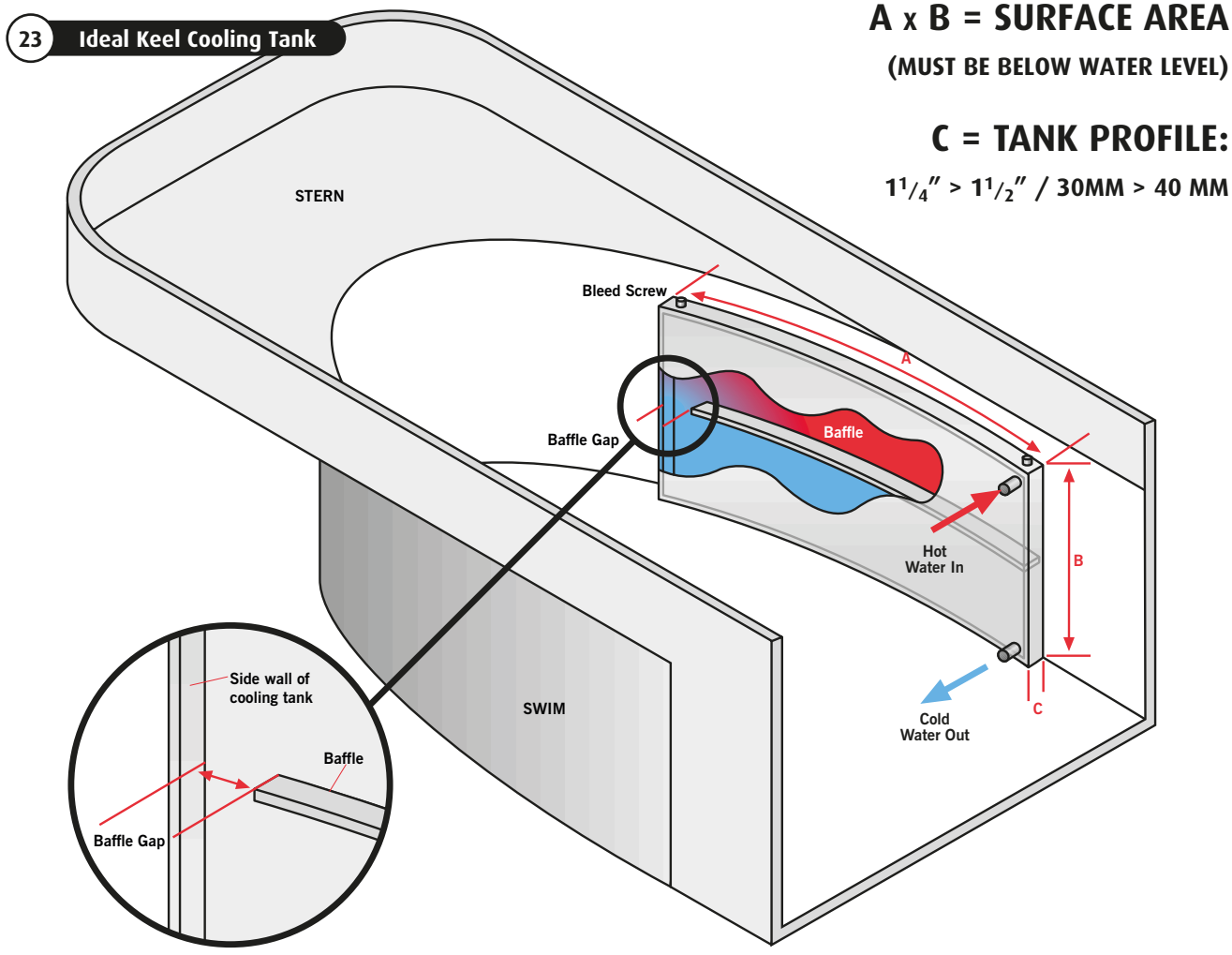
23 Ideal Keel Cooling Tank

A x B = SURFACE AREA

(MUST BE BELOW WATER LEVEL)

C = TANK PROFILE:

$1^1/_4$" > $1^1/_2$" / 30MM > 40 MM



NB: For Inland Waterway use, it is advisable to have twin full size tanks when cooling a generating set as they are most frequently used when the Narrowboat, Wide Beam or Dutch Barge is moored. This will ensure that one of the tanks always has access to adequate outside cooling water.

KEEL COOLING - DRY EXHAUSTS

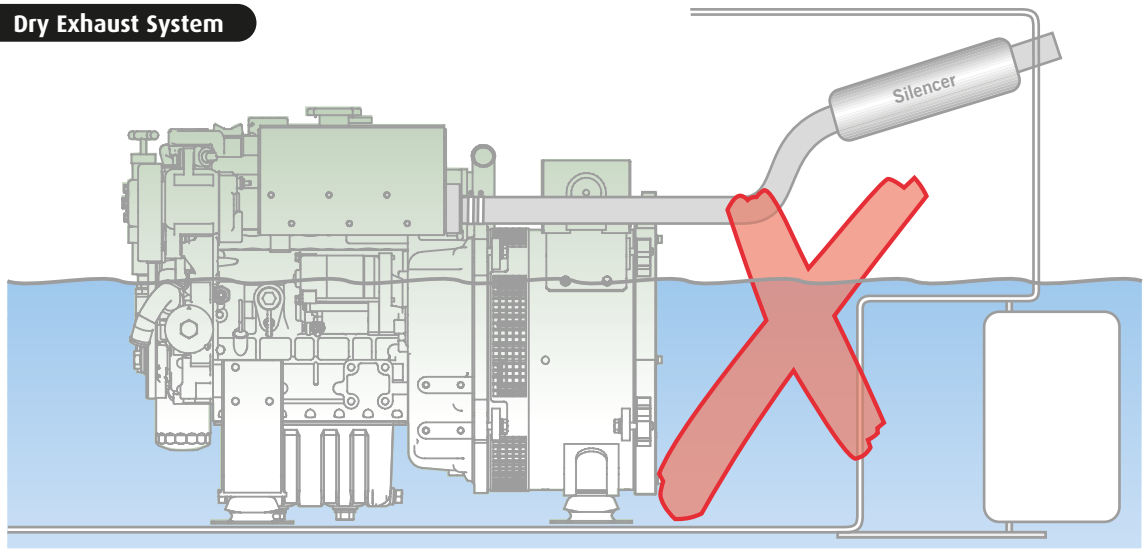
a) An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (Recreational Craft Directive).

b) Keep exhaust systems to a minimum length and have gradual bends.

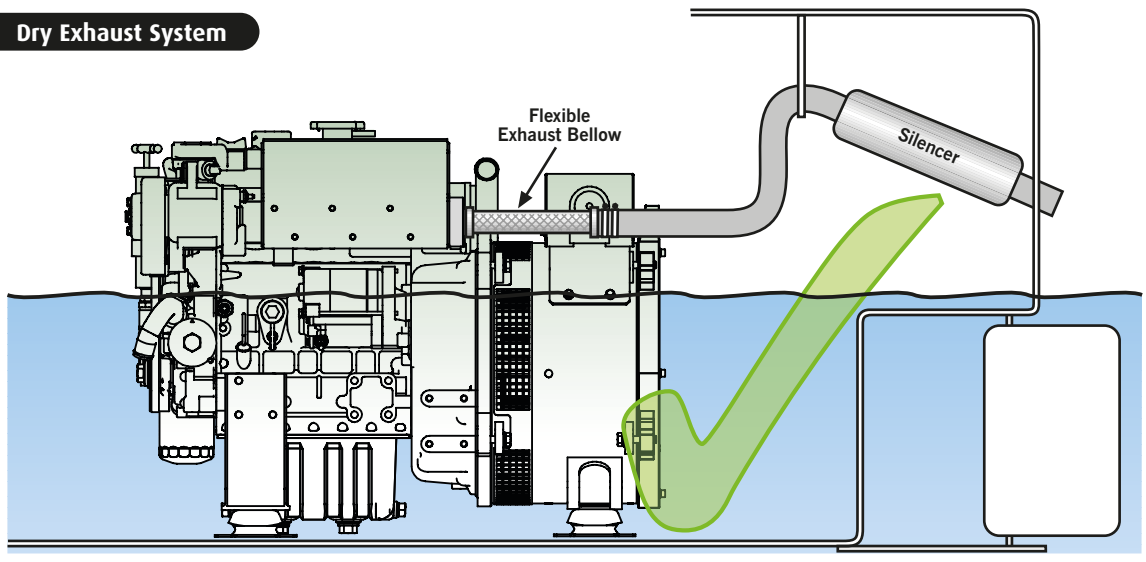
c) Keel cooled generating set engines depending on the model will be fitted with either a $1^1/_2$" or 2" male dry exhaust stub and should always a have a flexible exhaust bellow and dry exhaust silencer connected. It is up to the installer to work out the most appropriate pipe run but care should be taken as follows:

- Never use a flexible exhaust bellow as a bend, it will crack, always keep them straight.
- Hydraulic lock, occurs when water is allowed to enter the combustion chamber via the exhaust and 'hydraulics' against the rising piston with the consequences possible being, a bent con rod/s, an emulsified engine oil and/or a damaged fuel pump. It is imperative that it is avoided, always ensure that canal, river or sea water cannot enter the exhaust port and run back down the pipe, flooding the silencer and then the engine. Please refer to image 24 & 25.
- The system should be lagged if there is any danger of the crew getting near it.
- A dry exhaust system will give off considerable heat and suitable insulation and ventilation must be provided, please refer to page 30.

24 **Dry Exhaust System**



25 **Dry Exhaust System**



Ensure exhaust raises then falls to outlet

EXHAUST CONNECTION

Dry exhaust connections should be matched to the dry exhaust stub diameter. An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (Recreational Craft Directive).

BetaSet-BetaGen	Hose I.D
4/2, 6/2, 11/2, 22/2, 25/2, 7, 10, 12, 14 & 21	$1^1/_2$" BSP
26, 33, 40, 49, 40T IIIA & 49T IIIA	2" BSP

EXHAUST BACK PRESSURE

Exhaust back pressure should be as low as possible; it is increased by long exhaust length and sharp bends. Keep exhaust systems to a minimum length and have gradual bends avoid tight angled elbows. Back pressure should be measured with the complete exhaust system connected and the generating set running at service speed. The correct measuring point is before the injection bend (at the manifold flange).

BetaSet-BetaGen	Exhaust Back Pressure
4/2, 6/2 & 11/2	Max. 70 mm Hg
7, 10, 12, 14, 21, 22/2 & 25/2	Max. 80 mm Hg
26, 33, 40 & 49	Max. 90 mm Hg
40T IIIA & 49T IIIA	85 to 115 mm Hg

FUEL SYSTEM

26 Fuel/Water Separator

WARNING!

Always fit a fuel/water separator in the fuel supply system. Water in the fuel can seriously damage the injection system.

- If a fuel supply shutoff valve is fitted do not use a taper tap, only use a ball valve tap. The ball valve type are more reliable and less likely to let air into the fuel system.
- Be sure to use a strainer when filling the fuel tank. Dirt or sand in the fuel may cause trouble in the fuel injection pump.
- Always use diesel fuel. **Do not use paraffin/ kerosene**, as this has a low cetane rating and adversely affects the engine.
- Biodiesel fuel can be added to the normal diesel fuel up to a maximum limit of 7% without affecting the warranty.
- Most diesel fuels now contain up to a maximum limit of 7% Biodiesel and this does not affect the engine warranty. The recent changes to fuel specifications allow the addition of FAME (fatty acid methyl ester) Biodiesel EN14214:2009, to diesel fuel, but please be aware that Biodiesel does allow bacteria to grow more easily in the fuel and this can clog your fuel tank, pipes and filters. If you experience an outbreak of bacterial growth you can either empty and clean out your fuel pipes and tank, or use biocide additives and filtering.
- Low sulphur diesel fuel - regulations changed recently reducing the sulphur content by 99%, in many countries. The European standard is EN590:2009, and in the USA ASTM D975-09. The engine is designed to run on low sulphur fuel, and this is now preferred.
- If you use a higher percentage of Biodiesel fuel you must fit an electric lift pump into the fuel supply line, and the fuel filter and oil filter must both be changed together when the oil filter is normally replaced.

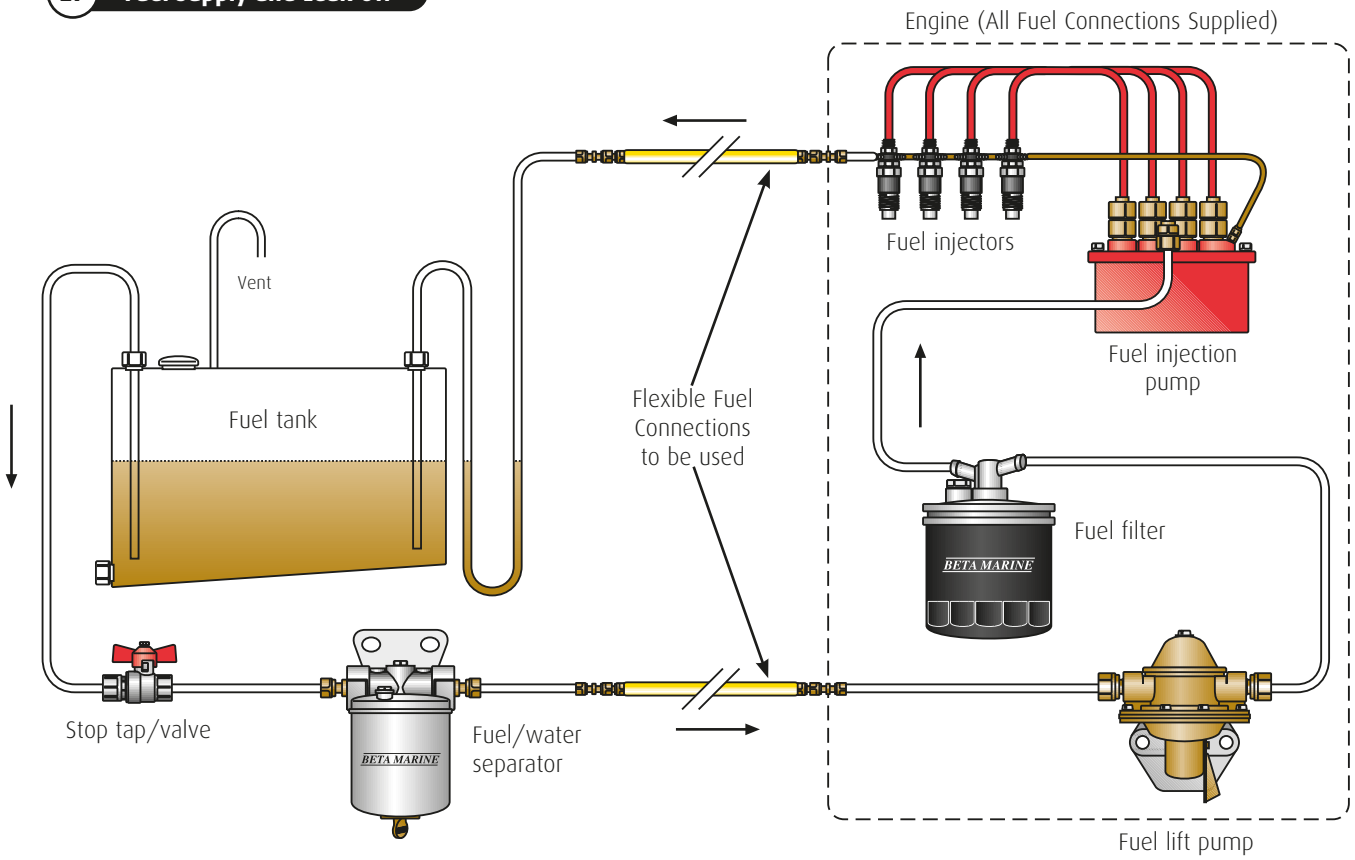
IMPORTANT!

Beta Marine warranty will not cover fuel equipment when more than 7% Biodiesel is used.

- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.
- The engine mechanical fuel lift pump will only lift fuel through 0.25m. If this is insufficient then an electric fuel lift pump must be fitted.

FUEL SUPPLY & LEAK OFF

27 Fuel Supply and Leak Off



NOTES:

1. **A fuel/water separator must be installed.**
2. The mechanical fuel lift pump is fitted to all engines as standard, but if a suction head of 0.25m or more is required, then an electric fuel lift pump must be fitted.
3. It is very important that the excess fuel from the injectors is fed back to the fuel tank and not back to any point in the supply line. This will help prevent air getting into the system.
4. The fuel return (leak off) pipe must loop down to be level with the bottom of the tank before it enters the top of the tank, please refer to image 27. This prevents fuel 'drain down'.
5. Fuel lines and hoses connecting the fuel tank to the engine, must be secured, separated and protected from any source of significant heat. The filling, storage, venting, fuel supply arrangements and installation must be designed and installed so as to minimise the risk of fire. When connecting the engine to the fuel supply and return lines, marine grade flexible fuel hoses are highly recommended.
6. Any fuel leaks in the system when static are likely to cause poor starting and erratic running and must be corrected immediately. These leaks will allow air to be sucked in when the engine is running.

FUEL CONNECTIONS

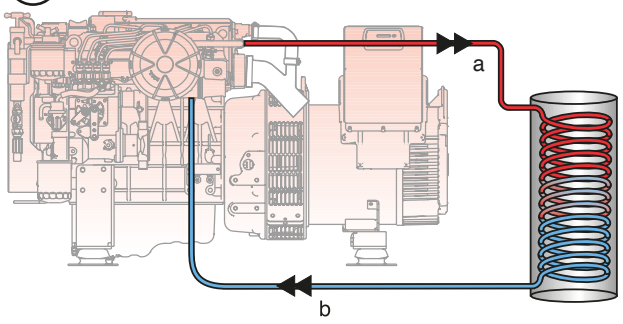
Engine Connector	Hose O.D
Fuel supply and leak-off connections are 8 mm conex with olives	8 mm O.D

CALORIFIER CONNECTIONS

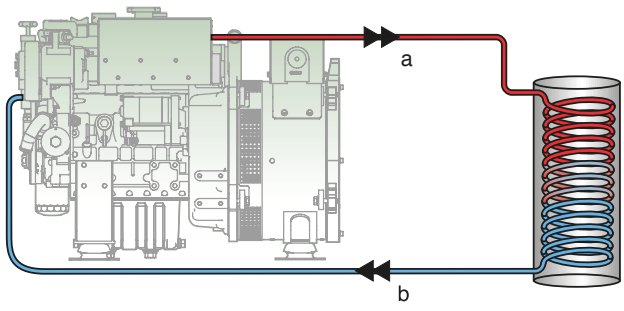
Generating Set engines can be fitted with optional calorifier connections so that the engine coolant circuit is allowed to flow through a calorifier tank to heat water for domestic use. Typical calorifier circuits and connection locations for heat exchanger & keel cooled generating sets are shown below. When installing please note:

1. For a calorifier to operate it is essential for all the air to be removed from the system.
2. If the calorifier tank or pipework is fitted above the heat exchanger or header tank (keel cooled) then you will need to fit a remote header tank slightly above the calorifier tank.
3. Keep the supply pipe either horizontal or sloping down in a continuous fall towards the calorifier. The return pipe should also be either horizontal or sloping down in a continuous fall towards the engine to avoid air pockets being created.
4. Extra care must be taken when first connecting the calorifier system to the engine as the coolant level in the heat exchanger or header tank (keel cooled) will drop as the circuit is filled. Once connected fill the coolant level as described in 'Filling The Fresh Water System' then run the engine off load for 10 minutes. Allow to cool to a safe temperature, then re-check the level and top up as necessary. Check the calorifier feed pipe to see if it is starting to warm. Run the engine for another ten minutes then repeat this process until the coolant level remains stable.
5. If the coolant level is steady but no warm water is arriving into the calorifier then (stop the engine and once suitably cooled down) using appropriate personal protective equipment carefully remove the heat exchanger or header tank (keel cooled) pressure/filler cap. Refer to the calorifier manufacturers instructions, then open the calorifier bleed valve and allow all air to escape before refastening. If no bleed valve is provided loosen the clip which secures the supply pipe to the calorifier and allow all air to escape before refastening. Repeat step 4.

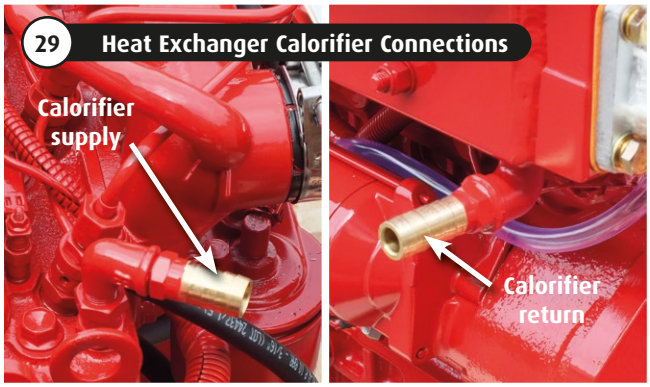
28 Heat Exchanger Calorifier System



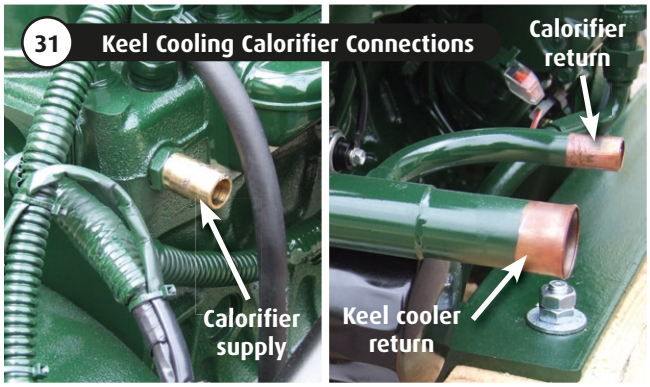
30 Keel Cooling Calorifier System



29 Heat Exchanger Calorifier Connections



31 Keel Cooling Calorifier Connections



⚠ CAUTION!

TO AVOID PERSONAL INJURY: Do not do this when the engine is hot as scalding hot water may be forced out of the pipe under pressure.

Calorifier Connector Hose I.D
Require $^{5}/_{8}$" / 15 mm I.D

The calorifier connection will be located as follows:

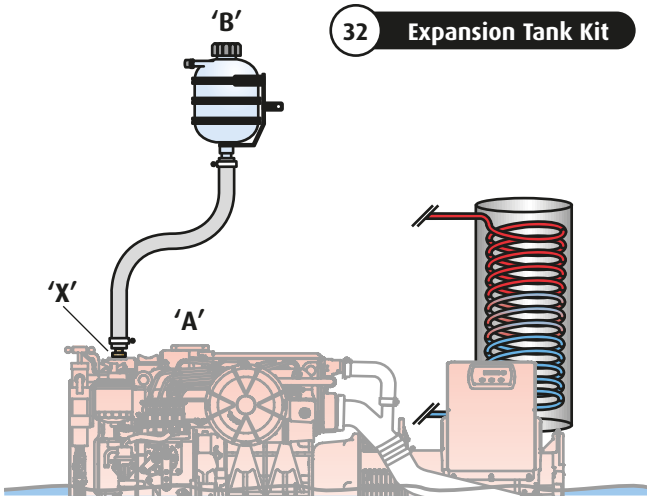
BetaSet-BetaGen All Heat Exchanger Variants:

- **Supply** - engine block top, starboard side when viewed from the AC alternator end.
- **Return** - bottom of heat exchanger, port side, exhaust end when viewed from the AC alternator end.

BetaSet-BetaGen All Keel Cooled Variants:

- **Supply** - engine block top, starboard side when viewed from the AC alternator end.
- **Return** - will be a T pipe into the keeler cooler return pipe, port side towards the front end when viewed from the AC alternator end.

ENGINE COOLANT REMOTE HEADER EXPANSION TANK KITS



32 Expansion Tank Kit

33 Expansion Tank Kit

If the calorifier position is partly above the engine it will be necessary to install a remote header expansion tank in a position higher than it.

Remote header expansion tank kit – when ordered with an engine or generating set, the kit is supplied loose but the required $^{3}/_{8}$" BSPT is pre-installed ready for connection. If a kit is retrospectively being fitted, the engine thermostat housing will require drilling and tapping $^{3}/_{8}$" BSPT to enable the $^{3}/_{4}$" hose tail to be connected **'X'**.

'A' - The heat exchanger pressure cap must always be Beta Marine, P/N 209-80130 rated @ 13 PSI.

'B' - The remote header expansion tank pressure cap must always be Beta Marine, P/N 209-03066 rated @ 22 PSI.

NB: When filling or topping up the coolant system, always fill point **'A'** before point **'B'**.

⚠ IMPORTANT!

When a remote header tank expansion kit is initially installed the tank will require to be re-calibrated.

Refer to and follow preceding CALORIFIER CONNECTIONS and following FILLING THE ENGINE COOLANT SYSTEM overleaf first.

Once completed and the engine, calorifier system and expansion header tank are all fully cooled additionally:

Mark the level that is now in the expansion header tank to use as a reference for the correct "Normal" coolant level.

ENGINE COOLANT

The coolant solution must be a mixture of 70 > 50% fresh water and 30 < 50% anti-freeze. This requirement also applies to warm and tropical climates as the solution additionally helps to prevent overheating and corrosion forming within the engine cooling circuit. The anti-freeze in the fresh water system enables the boiling point of water to rise to 124°C with a 13 psi pressure cap fitted. The water temperature alarm switch will however be activated at 95°C to 100°C. If no anti-freeze or a very weak solution is used, then the water temperature switch may not be activated before coolant is lost. Warranty is invalid if the correct percentage/ratio is not used.

⚠ IMPORTANT!

Always use a Mono Ethylene Glycol Based Extended Life Anti-freeze must be a mixture of 30 < 50% anti-freeze and 70 > 50% fresh water.

⚠ IMPORTANT!

Do not exceed an Antifreeze mix greater than 50%, as the engine cooling efficiency will be detrimentally affected.

FILLING THE ENGINE COOLANT SYSTEM

⚠ WARNING!

New engines are supplied with the engine coolant drained off.

To initially correctly fill the engine closed circuit coolant system:

a) Check that the coolant drain tap or plug is turned off. Please refer to image 34.

b) Fill engine with a correctly mixed engine coolant through the top of the heat exchanger or header tank. Please refer to image 35.

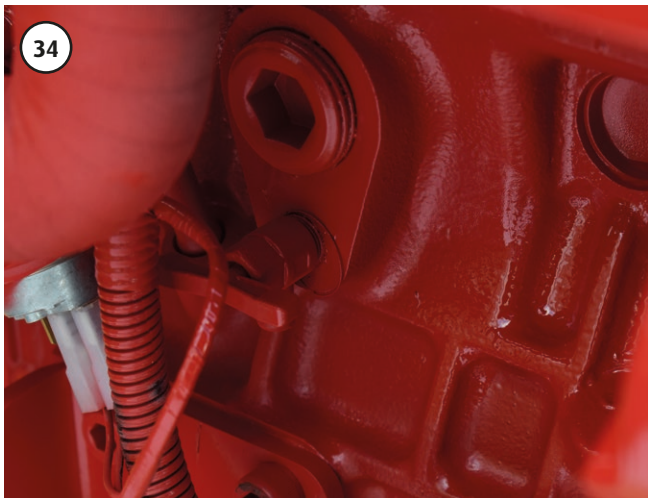
Coolant drain taps are located:

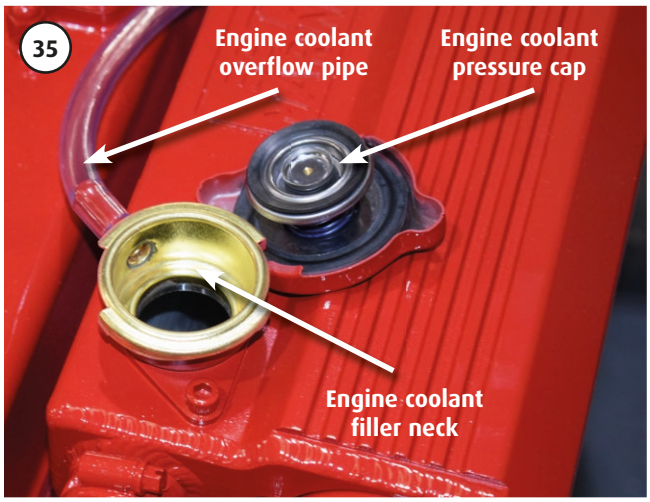
BetaSet-BetaGen 7, 10 & 12
Forward end, port side when viewed from the AC alternator end.

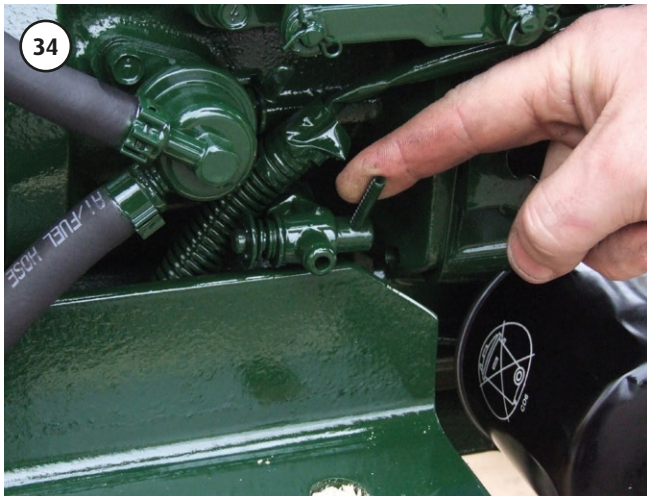
BetaSet-BetaGen 14 & 21
Forward end, starboard side when viewed from the AC alternator end.

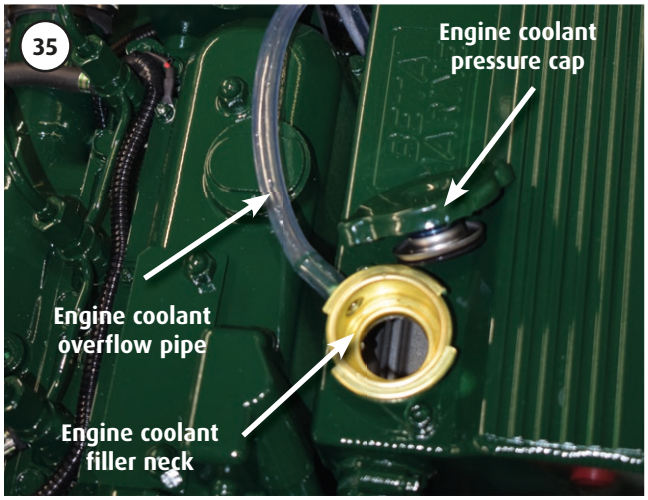
BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
AC alternator end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Forward end, starboard side when viewed from the AC alternator end.









c) Fill heat exchanger or header tank to the **top of the filler neck** and replace cap. Press down firmly on filler cap and hand tighten in a clockwise direction.

NB: Keel cooled engines require a large quantity of engine coolant which is dependent upon the size of the entire keel cooling system capacity. Please refer to the vessels build specifications and or builder for guidance.

d) Run the engine for 5 minutes on no load AC electrical, then stop the engine, release the filler neck pressure cap to remove any air from the system, remove the cap and check the level. Top up coolant to the filler neck and replace the filler pressure cap.

e) Check the cooling system for leaks.

NB: For keel cooled engines it is very important to bleed all of the air out of the complete engine cooling system before the engine is run on load. Please refer to the vessels build specifications and or builder for guidance.

f) If a calorifier is fitted care must be taken to see that this is also full of coolant and all the air is bleed from the calorifier circuit. Please refer to points 4 & 5 within 'Calorifier Connection' on page 44.

g) Run the engine for 15 minutes with $^1/_3$ AC alternator load, as the system initially warms up excess engine coolant will be leaked off from the overflow pipe into the bilge*. Stop the engine and allow the engine to fully cool down before removing the pressure cap and topping up the engine coolant to **25 mm/1" below** the filler neck.

*Subject to installation it maybe possble to place a drip tray or container to catch coolant overflow.

h) Repeat (g) if engine coolant level is greater than 1 inch below the base of the filler neck when the engine has cooled down top up to level to 1 inch below.

i) Check the cooling system for leaks.

j) Run engine on $^2/_3$ AC alternator load for 20 minutes, check for leaks and repeat (h) & (i).

k) **Coolant should be drained off every 2 years and replaced with a new solution.**

NB: When draining the engine coolant system, ensure the engine has cooled sufficiently to prevent scalding from hot pressurised water. Prior to draining a cold engine, remove the filler cap from the header tank and then open the water drain tap (image 34). This allows the water to drain freely from the system. Please refer to image 35.

⚠ CAUTION!

TO AVOID PERSONAL INJURY:

Engine Coolant Pressure Cap

Removal of the pressure cap when the engine is hot can cause severe injury from scalding hot water under pressure, always allow the engine to fully cool.

Using appropriate personal protective equipment turn the cap anti-clockwise to the stop, this allows pressure to be released. Then press firmly down on the cap and continue to turn anticlockwise to fully release the cap.

To re-fit the cap align its tangs with filler neck, press down and firmly turn the cap clockwise until it fully meets the stop position.

⚠ IMPORTANT!

The engine thermostat starts to open at 71°C, as a consequence, the guide running temperature should be between 71 > 85°C.

DC BATTERY INSTALLATIONS

Starter batteries and battery cables are a major consideration for engine starting systems. Incorrect selection of both battery and cables is a major cause of starting failure.

BATTERIES

1. Battery sizes: For starter battery capacity recommendation please refer to 'Technical Specifications' on pages 12 to 29.
2. In extreme conditions, low temperatures, battery capacity needs to be increased as performance will decrease. This needs to be allowed for during selection of a battery.
3. Battery terminals and connections must always be kept clean, in good condition and tight. Faulty connections can lead to poor performance and/or in extreme conditions explosion.
4. Batteries must be in good condition and must hold voltage. When measured, an idle standing battery would be expected to be read a minimum of 12.6 volts and 12 volts on the starter motor terminals.
5. Charging circuits must be sufficient for the battery system used. Ensure you have enough battery capacity whilst considering the recharge capability. Depending upon the battery type the recharge voltage will be in the region of 14.7 volts.

⚠ WARNING!

Under no circumstances should the battery be disconnected or switched off when the engine is running. This will seriously damage the engine starter battery alternator.

⚠ IMPORTANT!

Batteries should be protected from any possible ingress of water, firmly secured and have a battery isolation switch fitted to the positive cable before it reaches the engine.

BATTERY CABLES

1. Battery cables are sized on the motoring or rolling current of the starter motor and the length of battery cable run. This length is the total distance of both the positive and negative cables added together. Under normal circumstances the voltage drop in the starter battery cable circuit should not exceed 0.8 volt and in any circuit should not exceed 1.2 volts.
2. Starter batteries should be as close to the engine as practically possible. The reason for this is to ensure that the maximum voltage from the battery is available to the starter motor. The longer the cable run the more the voltage drop will be, due to resistance within the cables.
3. For smaller engines we recommend battery cables of 25mm^2 (4 AWG) conductor cross sectional area with length up to 1.5m per cable. This equals a cable run of 3m total which would have a voltage drop of 0.8 volts if the starter motor was using 160 amps when motoring. Battery cables that are too small will overheat and their insulation could catch fire.
4. When the supply is switched on to the starter motor there will be a massive inrush of power in the region of 5 times the motoring current. The battery will be expected to supply this inrush and then recover sufficiently to give the motoring current (often refered to the 'rolling' or 'cranking' current). If the correct battery is selected but the engine will not crank at sufficient speed after the inrush then (assuming battery cables are the correct size) the battery is either discharged or faulty.
5. If the voltage at the starter motor terminals after the inrush is not at least 10.5 volts it is likely that the motor will either crawl at insufficient speed or not turn at all. Battery cables could overheat.
6. Please note that cranking time should be no longer than 10 seconds with at least a 10 second rest between attempts.

25mm² (4 AWG) Cable

BetaSet-BetaGen	Cranking Amp	Cable Volt drop*	Max length, both cables added together
7, 10, 12, 4/2, 6/2, 11/2, 22/2 & 25/2	100	0.00017V	4.7m
14 & 21	120	0.00017V	3.9m

35mm² (2 AWG) Cable

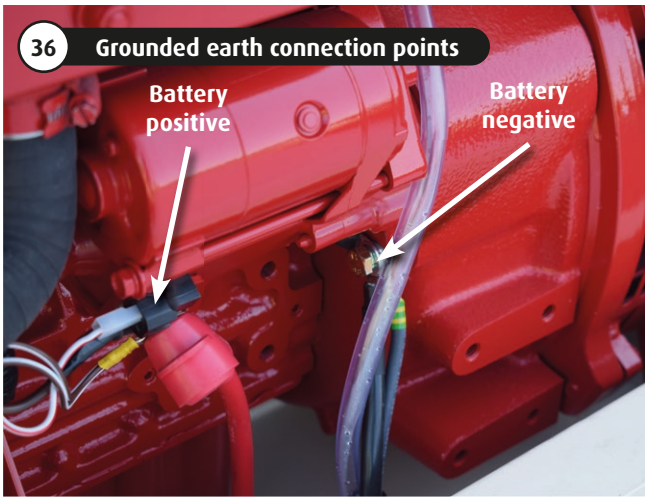
BetaSet-BetaGen	Cranking Amp	Cable Volt drop*	Max length, both cables added together
7, 10, 12, 4/2, 6/2, 11/2, 22/2 & 25/2	100	0.00013V	6.2m
14 & 21	120	0.00013V	5.2m
26, 33, 40, 49, 40T IIIA & 49T IIIA	210/250**	0.00013V	2.5m

70mm² (2/0 AWG) Cable

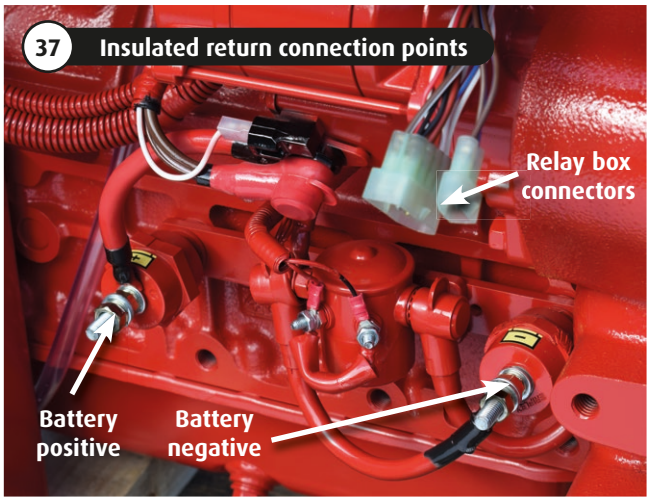
BetaSet-BetaGen	Cranking Amp	Cable Volt drop*	Max length, both cables added together
7, 10, 12, 4/2, 6/2, 11/2, 22/2 & 25/2	100	0.000063V	12.7m
14 & 21	120	0.000063V	10.5m
26, 33, 40, 49, 40T IIIA & 49T IIIA	210/250**	0.000063V	5.0m

* Voltage drops for pvc insulated cables are ex table 9D1 of the IEE Wiring Regulations.
** Varies between models and builds.

The above tables are based on a maximum conductor temperature of 70°C in an ambient temperature of 30°C.



BetaSet-BetaGen 7, 10, 14, 21, 4/2, 6/2, 11/2, 22/2 & 25/2



BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA

Battery connection location all Variants

Port side, near the engine starter motor, when viewed from the AC alternator end.

AC ELECTRICAL INSTALLATION

WARNING! - ELECTRICITY IS DANGEROUS AND CAN CAUSE DEATH IF THE GENERATING SET IS NOT CORRECTLY INSTALLED, MAINTAINED AND USED

IMPORTANT!

The decision to connect to the AC electrical output terminals of the generating set is the responsibility of a qualified/certified electrician who is also responsible for ensuring the safety, integrity & quality of the electrical circuit being connecting to.

WARNING!

Refer to the independent AC alternator manufacturer's operator manual originally supplied with the generating set. If required, replacement AC alternator PDF files can be be downloaded from our website:

www.betamarine.co.uk

ENGINE LUBRICANT

WARNING!

New engines are supplied with the engine lube oil drained off.

Engine oil: Engine oil quality should have the minimum properties of the American Petroleum Institute 'API' classification **CF** with multi-grade SAE ratings as listed in the following table.

NB: An acceptable alternative is a mineral based, semi-synthetic lubricating oil with a content mix no greater than 30% being synthetic based.

The adjacent table gives grades of oil viscosity required for various ambient temperature ranges.

Ambient Temp.	Multi-Grade
-30°C to 0°C	SAE 10W/30
-15°C to +15°C	SAE 15W/40
0°C to +30°C	SAE 15W/40
25°C and above	SAE 15W/40

IMPORTANT!

- **Do not mix two different types of oil or SAE rating.**
- **Do not use lubricant additives and/or fully synthetic lubricating oil.**

FILLING THE ENGINE WITH OIL

For quantities of oil required please refer to pages 12 to 29. When checking the engine oil level, do so before starting, or more than five minutes after stopping.

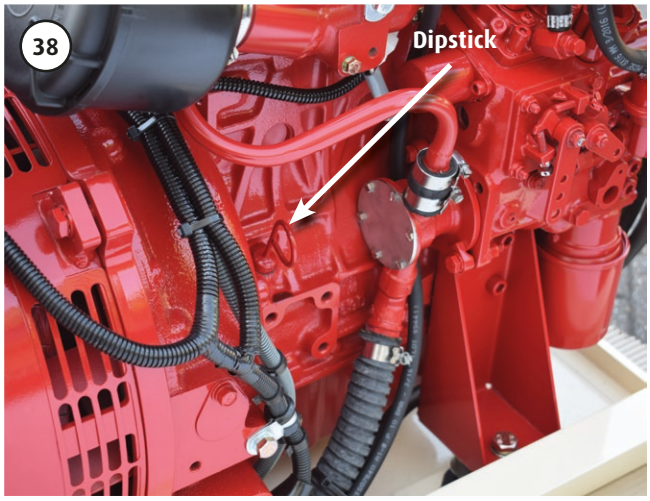
1. To check the oil level, draw out the dipstick, wipe it clean, re-insert it, and draw it out again, please refer to image 38. Check to see that the oil level lies between the two notches.
2. If the level is too low, add new oil to the engine to the specified level, please refer to image 39.

When using an oil of a different make or viscosity from the previous one, drain out the old oil. **Never mix two different types of oil.**

Engine oil should be changed after the first 50 hours running time and then every year or every 250 hours if sooner.

IMPORTANT!

Over-filling your engine with oil can be as detrimental as under-filling.



The dipstick will be located:

All BetaSet-BetaGen Variants

Mid engine, low level, starboard side when viewed from the AC alternator end.

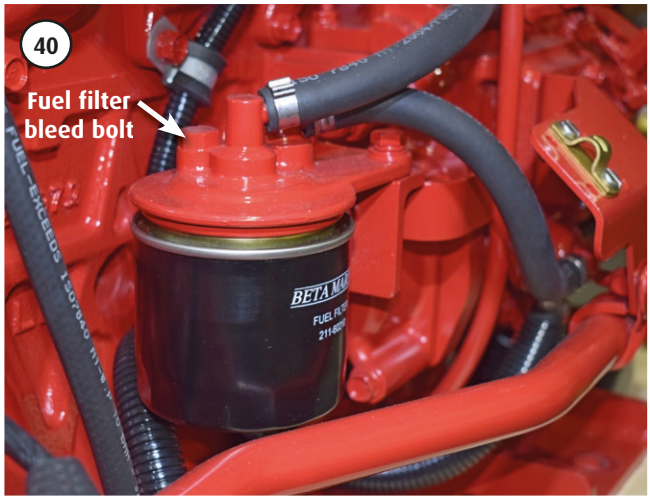
BLEEDING THE FUEL SYSTEM

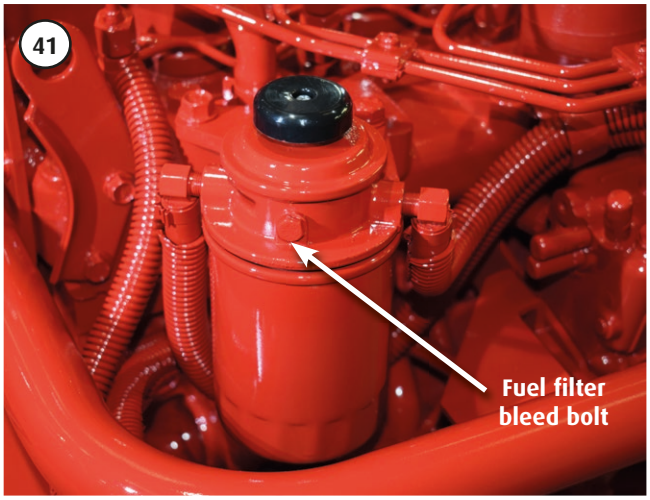
1. Bleeding the fuel system for initial start up.
2. The fuel system must have all the trapped air carefully 'bled' out; starting at the fuel tank and progressively working through to: the fuel/water trap, the fuel filter, to the fuel injection pump.
3. Open the fuel tank stop tap/valve and then bleed the fuel/water separator of air as shown in manufacturer's literature.
4. Fuel should now arrive at the fuel lift pump.
5. Open the fuel bleed bolt on top of the fuel filter by 1 to 2 turns, please refer to image 40 or 41.

⚠ CAUTION!

TO AVOID PERSONAL INJURY:

- **Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a fire.**
- **Do not mix petrol/gasoline or alcohol with diesel fuel. This mixture can cause an explosion.**
- **Fuel must be removed from skin to prevent infection.**





The fuel filter will be located:

HEAT EXCHANGER

BetaSet-BetaGen 7, 10 & 12
Forward end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 14 & 21
Under air filter, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
AC alternator end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Forward end, starboard side when viewed from the AC alternator end.

KEEL COOLED

BetaSet-BetaGen 7, 10 & 12
AC alternator end, starboard side when viewed from the AC alternator end.

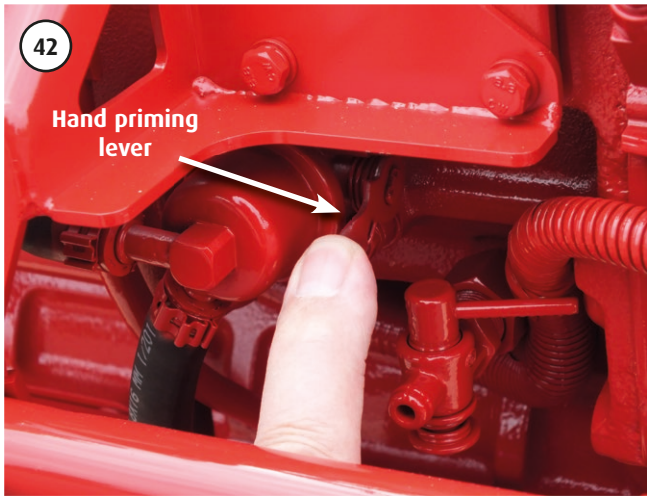
BetaSet-BetaGen 14 & 21
Under air filter, starboard side when viewed from the AC alternator end.

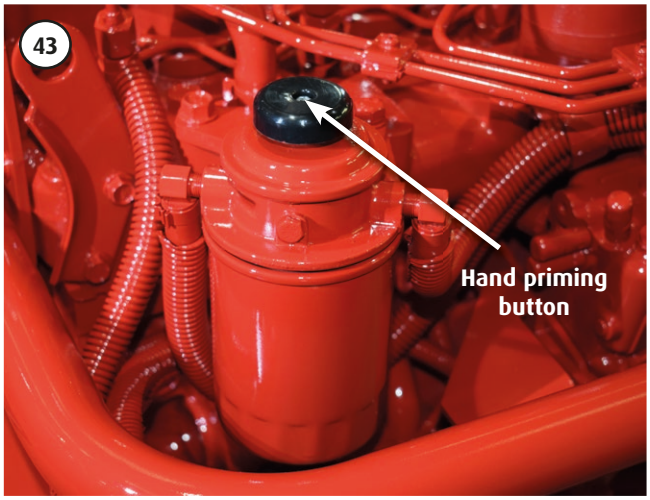
BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
AC alternator end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Mid engine, starboard side, when viewed from the AC alternator end.

Depending on generating set fuel filter type follow either steps 6 & 8 or steps 7 & 8.

6. Move the hand priming lever on fuel lift pump up and down (please refer to image 42) until fuel with "no bubbles" come out of the fuel filter bleed bolt (please refer to image 40). The hand priming lever normally has about 90° travel: **but the camshaft lobe may block this travel requiring you to rotate the engine crankshaft 90° to obtain full travel.**
7. Move the hand priming button on the fuel filter until fuel with "no bubbles" come out of the fuel filter bleed bolt, please refer to image 43.
8. Shut/tighten the fuel filter bleed bolt, please refer to image 40 or 41.





The hand priming lever or button will be located:

HEAT EXCHANGER

BetaSet-BetaGen 7, 10, 12, 14 & 21
Forward end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
AC alternator end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Forward end, starboard side when viewed from the AC alternator end.

KEEL COOLED

BetaSet-BetaGen All Variants
Have a hand button primer on the top of the fuel filter assembly.

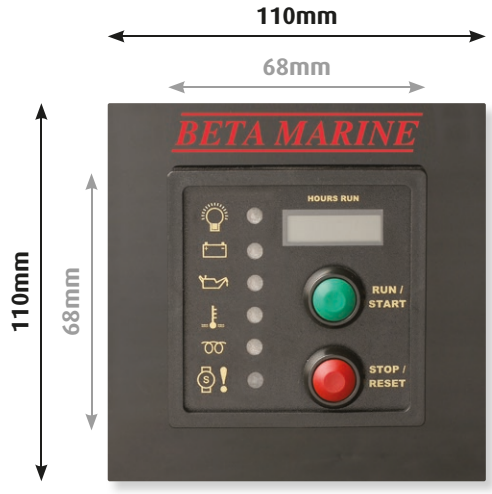
CONTROL MODULE OVERVIEW

PSM720 PUSH BUTTON START & STOP PROTECTION MODULE

STANDARD FOR THE BETASET-BETAGEN 7 THROUGH TO 21

This control module is micro-processor based for engine monitoring and alarms with protection*. Complete with manual push buttons for automatic engine start with timed pre-heat and engine stop, has an hours run meter and LED indicators for DC on, starter battery no charge, low lubricating oil pressure* and high water coolant temperature*.

*Automatic shutdown protection on fault function.

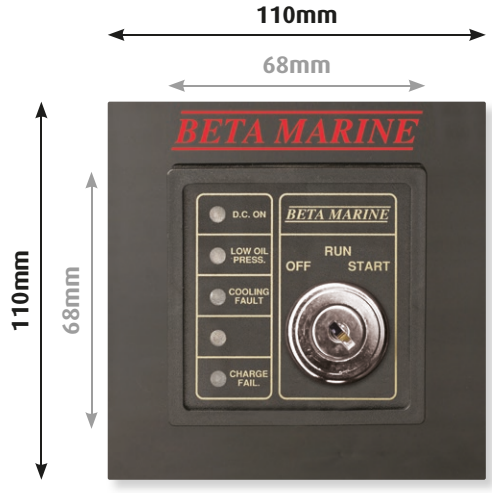


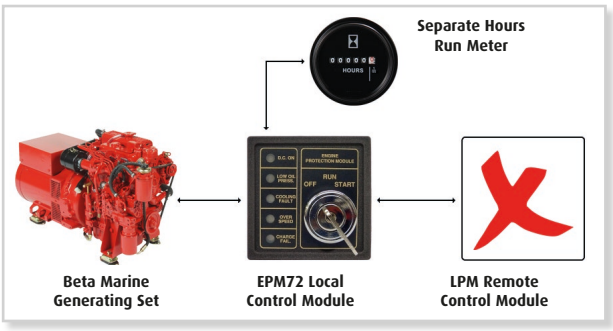
EPM72 KEY SWITCH START & STOP PROTECTION MODULE

STANDARD FOR THE BETASET-BETAGEN 26 THROUGH TO 49

Standard for generating sets specified with electrical insulated return engine starting. The control modules engine pre-heat, start and stop functions are operated by a manual key switch and has micro-processor based engine monitoring and alarms with protection. LED indication for DC on, low engine lubricating oil pressure*, high water coolant temperature* and starter battery no charge. It is supplied complete with a separate hours run meter.

*Automatic shutdown protection on fault function.





CONTROL MODULE OVERVIEW

RSM72 & LPM72 CONTROL MODULES FOR LOCAL & REMOTE OPERATION

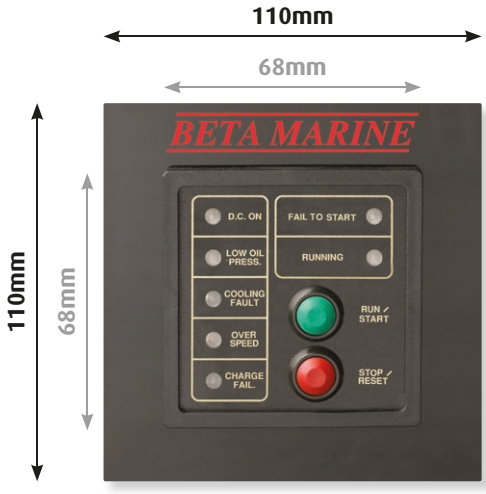
OPTIONAL FOR ALL BETASET-BETAGEN MODELS

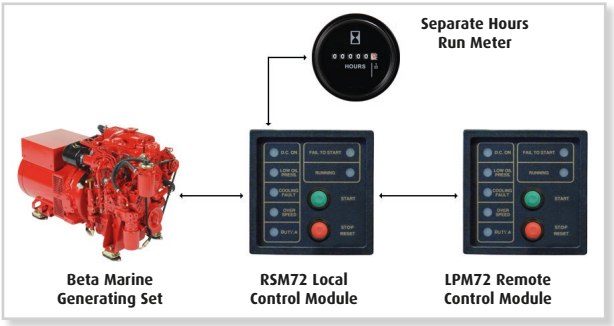
Compatible for all generating sets including those specified with electrical insulated return engine starting. Comprises of a RSM72 (remote start module) with a separate hours run meter for local installation and a LPM72 (lamp start module) for remote installation enabling full generating set control from two locations – in lieu of the standard module.

The main RSM72 is PCB based with engine start-stop buttons and alarms with protection*. Complete with manual push buttons for automatic engine start with timed pre-heat and engine stop, LED indicators for DC on, over speed, low lubricating oil pressure* and high water coolant temperature*.

*Automatic shutdown protection on fault function.

The secondary LPM72 remote module is visually identical and is interconnected to the main RSM72 by twin data ports/cables, this enables generating set control and engine monitoring from two separate locations. The modules are supplied loose with a 3m interconnection cable included for the RSM72, the required "custom" lengths of interconnection cable for coupling the LPM72 to the RSM72 are not included but are available at additional cost.





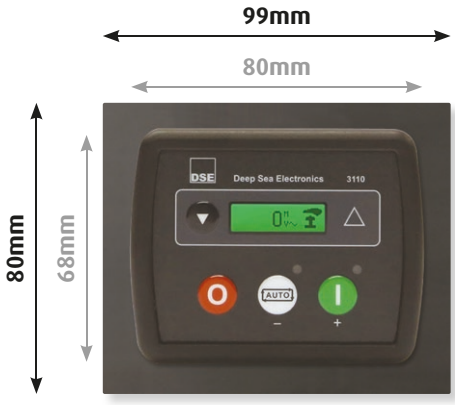
DSE3110 MANUAL & AUTO START CONTROL MODULE

OPTIONAL FOR ALL BETASET-BETAGEN MODELS

Compatible for all generating sets including those specified with electrical insulated return engine starting – in lieu of the standard module. The DSE3110 is utilised as a Manual or Auto Start Module for single generating set applications and provide advanced engine monitoring and protection features. It includes a back-lit icon LCD display which clearly shows the status of the engine at all times.

The module includes fixed and flexible outputs as well as configurable inputs making this product ideal for a wide variety of applications. The module can either be programmed using the front panel or by using the DSE Configuration Suite PC software. Complete as standard with engine control and monitoring functions for manual engine start, automatic engine start with timed pre-heat and engine stop, an hours run meter, over speed, low lubricating oil pressure*, high water coolant temperature* and power save mode.

*Automatic shutdown protection on fault function.



NB: This control module has its own independent operators manual.

CONTROL MODULE OVERVIEW

DSE7310 MK II CONTROL MODULE & DSE7310 MK II DISPLAY MODULE FOR LOCAL & REMOTE OPERATION

OPTIONAL FOR ALL BETASET-BETAGEN MODELS

The DSE7310 MK II is an Auto Start Control Module suitable for a wide variety of single, diesel generating set applications. Monitoring an extensive number of engine parameters, the module will display warnings, shutdown and engine status information on the back-lit LCD screen, illuminated LEDs, remote PC and via SMS text alerts (requires optional external modem). The module includes USB, RS232 and RS485 ports as well as dedicated DSENet® terminals for system expansion.

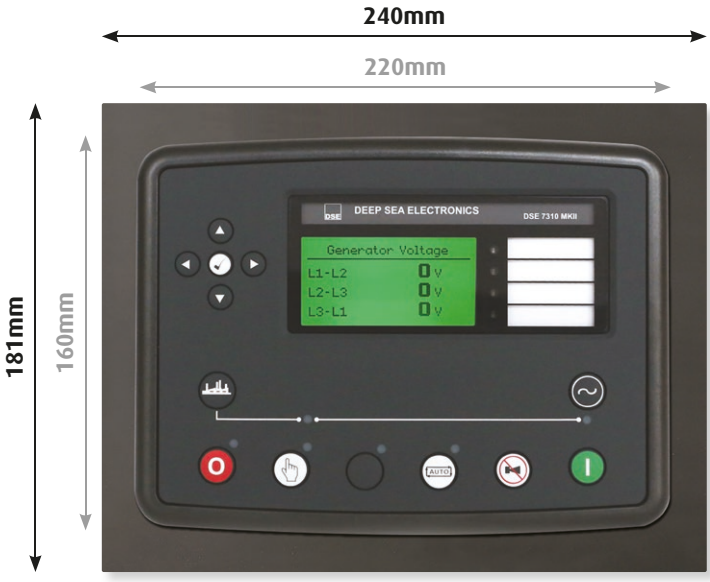
The module is compatible with electronic (CAN) and non-electronic (magnetic pick-up/alternator sensing) engines and offers an extensive number of flexible inputs, outputs and extensive engine protections so the system can be easily adapted to meet the most demanding industry requirements.

The extensive list of features includes enhanced event and performance monitoring, remote communications, PLC functionality and dual mutual standby to reduce engine wear. The module can be easily configured using the DSE Configuration Suite PC software. Selected front panel editing is also available.

The DSE7310 MK II has engine control and monitoring functions including manual engine start, automatic engine start with timed preheat, engine stop, engine hours run meter, over speed, low lubricating oil pressure* and high water coolant temperature*.

Up to three DSE7310 MK II display modules can be connected to a DSE7310 MK II control module, each can be positioned up to a maximum distance of 1km away. Each display module will remotely offer exactly the same instrumentation, control and monitoring capabilities as the host control module, including starting and stopping of the engine.

*Automatic shutdown protection on fault function.



NB: This control module has its own independent operators manual.

IMPORTANT!

BOTH DSE3310 & DSE7310 MK II MODULES ENSURE THAT ACCIDENTAL CONTACT WITH THE GENERATOR OUTPUT SUPPLY CANNOT HAPPEN.

NB: ALWAYS FIT A SHIELD OR THE BETA MARINE COVER ON TO THE BACK OF THE MODULE.

CONTROL MODULE INSTALLATION

CONTROL MODULES

Beta Marine offer 5 control module options, standard for BetaSet-BetaGen 7 to 21 is the PSM720, standard for the BetaSet-BetaGen 26 to 49 is the EPM72.

1. Control modules are supplied as standard with a 3m multi-core cable for connection to the engine wiring loom. Extension looms of 5m or more are available should your installation require it or you wish to relocate your existing module/s, all looms include a start relay to overcome the voltage drop.
2. For standard wiring diagrams see diagram index, page 89.

IMPORTANT!

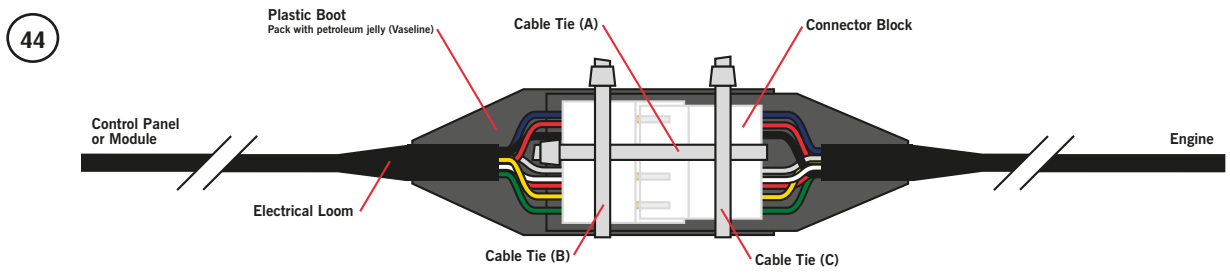
The module must be installed in a control panel giving adequate protection from adverse temperature, moisture and vibration.

Ensure there is adequate clearance behind the module so connection block/s and wiring is not at risk of being crushed.

If the module is to be generating set mounted locally by the installer, suitable anti-vibration mounts must be used.

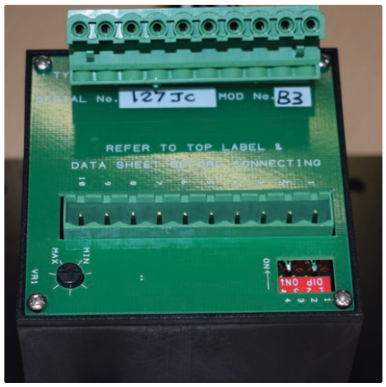
CONNECTING INTERCONNECTION CABLES

1. All electrical equipment must be protected from water. To prevent corrosion and assist in connecting the cable to the control module of the engine we recommend that the plug boots are packed with petroleum jelly (Vaseline).
2. Carefully roll the 2 plastic protective boots back over themselves and then push the 2 plug sockets together, check all pins are fully engaged then use a cable tie to lock them together (A). Pack the protective plastic boots with petroleum jelly (Vaseline) then roll them back to cover the plug sockets and overlap one over the other. 2 cable ties should then be used to help prevent help prevent any ingression of water (B & C), please refer to the illustration below.
3. All cables must be adequately clipped and protected from abrasion.
4. Electrical systems shall be designed and installed so as to ensure proper operation of the craft under normal conditions of use and shall be such as to minimise risk of fire and electric shock.
5. Attention shall be paid to the provision of overload and short circuit protection of all circuits, except engine starting circuits supplied from batteries.



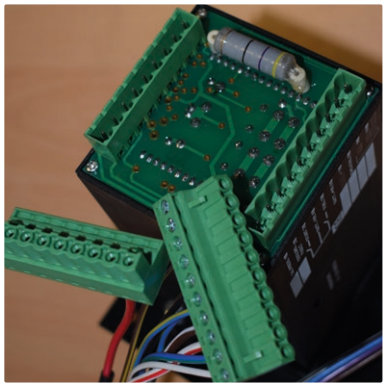
CONNECTING THE CONTROL MODULE

PSM720 Local Module Connection



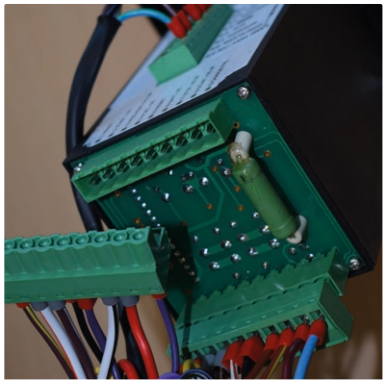
The PSM720 local module has a single 10 pin connection block, which is sculpted and the module connection socket correlates. Ensure the block sculpture and pins align and push the connection block home until the retaining clip engages.

EPM720 Local Module Connection



The EPM720 local module has 2 connection blocks, both of which are sculpted. One connection block has 10 pins and the other has 9 pins and the module connection sockets correlate. Ensure the block sculptures and pins align and push the connection blocks home until the retaining clip engages.

RSM720 Local Module Connection



The RSM720 local module has 3 connection blocks, all of which are sculpted. One connection block has 10 pins, a second has 9 pins and the third has 8 pins, the module connection sockets correlate. Ensure the block sculptures and pins align and push the connection blocks home until the retaining clip engages.

The RSM720 remote module has 2 connection blocks, both of which are sculpted. One connection block has 10 pins and the other has 6 pins and the module connection sockets correlate. Ensure the block sculptures and pins align and push the connection blocks home until the retaining clip engages.

Connection blocks can be disconnected from the module by using a small electrical screwdriver to release the retaining clips. **NB: Always ensure that the starter battery has been isolated first.**

Section 2: Initial Engine Start Up

INITIAL ENGINE START UP

IMPORTANT!

CHECKS PRIOR TO INITIAL START UP

Re-Check

1. Flexible mountings and engine room ventilation.
2. The wet (heat exchanger) or dry (keel cooled) exhaust.
3. The **heat exchanger cooling circuit**:
   - Open the sea-cock.
   - Check for any leakage.

Or **keel cooling circuit**.

4. The calorifier circuit (if installed)
5. Initial engine coolant levels.
6. Control module installation and connection.
7. Fuel system is initially bleed.
8. DC battery is fully charged and the isolator is switched to the ON position.
9. Ensure the engine is free to turn without any obstruction.
10. Ensure that all electrical covers are in place and correctly fitted. **Switch off any connected electrical loads.**

WARNING!

DO NOT engage the starter motor continuously for more than 10 SECONDS to prevent the risk of overheating.

INITIAL ENGINE START UP POINTS

If the engine has not started after **3 attempts**, there is a possibility that air is still in the fuel system. Switch off the control module and repeat "bleeding the fuel system". Hand prime the engine with the fuel lift pump lever or button for **30 seconds**, then re-attempt initial engine start up.

If engine does not start after **3 attempts** then allow 5 minutes for the starter to cool down before retrying.

If the engine does not start after **3 attempts**, **do not over crank** a heat exchanger engine with the seawater inlet sea-cock turned '**ON**'.

Close/shut off the seawater inlet sea-cock to stop seawater being pumped into the exhaust system to prevent the risk hydraulic lock occurring.

When you re-attempt initial engine start up and the **engine fires and runs** you must immediately **re-open** the sea-cock.

IMPORTANT!

All control modules fault check oil pressure before allowing the engine to start.

All control modules will allow 3 attempts to start before engine shut down on fault protection engages.

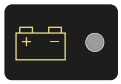
NORMAL STARTING AND STOPPING

PSM720 PUSH BUTTON START & STOP PROTECTION MODULE - FUNCTIONALITY

Turn on the starter battery isolation switch.

1 Press the green '**RUN/START**' button momentarily.

Red panel light for DC `power on` should illuminate.



Starter battery alternator not charging should illuminate.

Low engine oil pressure light will illuminate but the protection hold timer over rides this engine fault protection circuit on start up for 18 seconds after initial firing.

High engine temperature light will not illuminate.

Glow plug light will illuminate, for the duration of the programmed pre heat time - 10 seconds The engine will not start until the glow plugs have been fully pre heated and the light stops illuminating

Depending on the engine model the warning light may flash during the glow plug pre heat duration.

2 When the glow plug light stops illuminating.

Press and hold the green button for **no more than 9 seconds** to start the engine. When the engine cranks and then fires, release the green button to disengage the starter motor. If the green button is pressed and the starter is operated for **10 seconds**, the module will shut down on overcrank fault protection and the warning light will illuminate.

3 Once the engine has run up to operating speed, the engine protection hold off timer will countdown from 18 seconds, once done all engine fault protection circuits become live. All lights except DC on should stop illuminating. In the event of a engine protection fault the appropriate light will illuminate and the engine will shut down.

4 If the engine does not start after initial **9 seconds**, wait **20 seconds** before re-attempting start by pushing in the green button for no more than **9 seconds**.

5 Pressing the red '**STOP/RESET**' button will shut down the engine if running or reset the module and fault protection circuits if already stopped. Should the engine not start after 3 attempts, press the red button for the module to operate all fault protection shutdowns and reset. Then repeat step 1 & 2.

Engine Shut Down Fault Protection

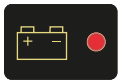
The generating set will automatically shut down for the following fault protection circuits.

Low Engine Oil Pressure

High Engine Temperature

Engine Fault Warning

The generating set will not automatically shut down for the following engine fault warning.



DC Alternator charge fail

⚠ WARNING! THE STARTER MOTOR WINDINGS CAN BE BURNT OUT WITH CONTINUOUS CRANKING.

NORMAL STARTING AND STOPPING

EPM72 KEY SWITCH START & STOP PROTECTION MODULE - FUNCTIONALITY

Turn on the starter battery isolation switch.

1 Turn the key switch to '**RUN**' momentarily.

Starter battery alternator not charging should illuminate.

Red panel light for DC `power on` should illuminate.

Low engine oil pressure light will illuminate but the protection hold timer over rides this engine fault protection circuit on start up for 18 seconds after initial firing.

High engine temperature light will not illuminate.

Fourth light is not used.

Red panel light for DC `power on` should illuminate.

2 Turn the key switch to '**START**' and hold. The engine starter motor will **not engage** until after the duration of the programmed pre heat time **> 6 seconds**. When the engine cranks and then fires, release the key switch to disengage the starter motor.

3 Once the engine has run up to operating speed, the engine protection hold off timer will countdown from 18 seconds, once done all engine fault protection circuits become live.

All lights except DC on should stop illuminating. In the event of a engine protection fault the appropriate light will illuminate and the engine will shut down.

4 If the engine does not start after initial **9 seconds** of cranking release the key switch and wait **20 seconds** before re-attempting start. Return the key switch to the '**START**' position and hold, do not crank the engine for more than **9 seconds**.

5 Turning the key switch to '**OFF**' will shut down the engine if running or reset the module and fault protection circuits if already stopped.

Should the engine not start after 3 attempts, turn the key switch to '**OFF**' for the module to operate all fault protection shutdowns and reset. Then repeat step 1.

Engine Shut Down Fault Protection

The generating set will automatically shut down for the following fault protection circuits.

Low Engine Oil Pressure

High Engine Temperature

Engine Fault Warning

The generating set will not automatically shut down for the following engine fault warning.

DC Alternator charge fail

WARNING! THE STARTER MOTOR WINDINGS CAN BE BURNT OUT WITH CONTINUOUS CRANKING.

NORMAL STARTING AND STOPPING

RSM72 LOCAL & LPM72 REMOTE OPERATION - FUNCTIONALITY

Turn on the starter battery isolation switch.

Using either the RSM72 local or LPM72 remote module.

1 Press either green '**RUN/START**' button momentarily.

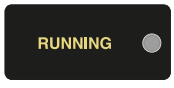
Both green panel lights for DC `power on` should illuminate.

Both low engine oil pressure lights will not illuminate, as the protection hold timer over rides this engine fault protection circuit on start-up for 18 seconds after initial firing.

Both high engine temperature lights will not illuminate as the protection hold timer overrides this fault protection circuit on start-up for 18 seconds after initial firing.

Both AC alternator over speed lights will not illuminate as the protection hold timer over rides this engine fault protection circuit on start-up for 18 seconds after initial firing.

Both fail to start lights will not illuminate.



Both running lights will not illuminate.

Both charge fail lights will not illuminate for up to six seconds, this is the duration of the glow plug programmed pre heat time.

At this moment they will both illuminate to indicate that the generating set is about to enter "**AUTO-START**" mode and the engine will crank, fire and run.

Both DC power on lights will continue to illuminate.

Both running lights will illuminate.

Both low engine oil pressure lights should not illuminate.

Both high engine temperature lights should not illuminate.

Both over speed lights should not illuminate.

Both fail to charge lights should not illuminate.

Both fail to charge lights should not illuminate.

If the generating set fails to "**AUTO-START**" and run after the programmed engine crank time, both fail to start lights will illuminate. Should this occur proceed to step 2 then repeat step 1.

2 Pressing the red '**STOP/RESET**' button will shut down the engine if running or reset the module and fault protection circuits if already stopped.

Engine Shut Down Fault Protection

The generating set will automatically shut down for the following fault protection circuits.

Low Engine Oil Pressure

High Engine Temperature

AC alternator over speed

Engine Fault Warning

The generating set will not automatically shut down for the following engine fault warning.

DC Alternator charge fail

NB: Please note that both modules can be used to start, monitor, stop & reset the fault protection circuits. However only the RSM72 controls the pre-programmed engine parameters for engine fault protection. Any adjustment to these parameters can only be made on this module. Once made the LPM72 automatically defaults to the RSM72 parameters.

Section 3: Maintenance Guidelines

MAINTENANCE SCHEDULE

DAILY OR EVERY 8 HOURS RUNNING

Visually check the generating set for any obvious fault, leaks or damage – clean or repair if required.

- Check engine oil level.
- Check coolant level.
- Check battery fluid.
- Check belt tension and alternator bolts.
- Ensure raw water inlet strainer is clear.
- Drain off any water in fuel/water separator.

AFTER THE FIRST 25 HOURS RUNNING

- Check that all external nuts, bolts and fastenings are tight. **Do NOT over tighten.** Special attention should be paid to the flexible mount lock nuts, these should be checked for tightness, starting with lower nut first in each case. Poor alignment due to loose flexible mount nuts will cause excessive vibration and knocking.
- Check and adjust all drive belt tensions.

AFTER FIRST 50 HOURS

- Change engine lubricating oil.
- Change oil filter.
- Check for leaks on header tank tubestack. Tighten end cap bolts if required.
- Drain off any water in fuel/water separator.

AFTER 150 HOURS

- If shallow sump (option) is fitted, change engine lubricating oil and filter.

EVERY YEAR OR 250 HOURS IF SOONER

- Change engine lubricating oil.
- Change lubricating oil filter.
- Change fuel filter.
- Check air cleaner element.
- Check sea water pump impeller and change if worn.
- Check wasting anode condition, replace when necessary.
- Remove heat exchanger tube stack, by undoing the bolts each end of the tube stack. Remove end cover, pull out tube stack and clean. Replace rubber 'O' rings and re-assemble. Top up with anti-freeze. Immediately engine is started check for leaks.
- Check that all external nuts, bolts and fastenings are tight.

EVERY 750 HOURS (IN ADDITION TO 250 HOURS MAINTENANCE)

- Change air cleaner element.
- Check valve clearance.

EVERY 1500 HOURS

- Check injection nozzle pressure.

Maintenance Schedule

	Daily or after every 8hrs running	After first 25hrs	After first 50hrs	Every 150hrs*	Annually or 250hrs if sooner	Every 750hrs	Every 1500hrs
Check engine oil level	●						
Change engine oil			●	●	●		
Change engine oil filter			●	●	●		
Check engine coolant/antifreeze level	●						
Check engine coolant/antifreeze condition**					●		
Check battery fluid	●						
Check belt tension/s and alternator bolts	●						
Check raw water inlet strainer is clear***	●						
Drain off any water in fuel/water separator	●						
Change diesel fuel filter					●		
Check all external nuts, bolts and fastenings. Check condition of all coolant, fuel, oil pipes and clamps		●	●		●		
Lubricate keyswitch on control panel with petroleum jelly/WD40 or equivalent - if applicable			●		●		
Check sacrificial anode, **replace if necessary** - increase inspection frequency if heavy erosion experienced***			●		●		
Remove heat exchanger tube stack, clean and **replace** rubber o-rings***					●		
Check sea water pump impeller and **change if worn***					●		
Check air cleaner element, clean and **change if required** - increase inspection frequency if heavy soiling is experienced					●		
Change air cleaner element						●	
Check valve clearance						●	
Check injection nozzle pressure							●

* **Shallow sump equipped engines only**
** **Replace engine coolant/antifreeze every other year or 500hrs if sooner**
*** **Heat exchanger cooled only**

GENERAL MAINTENANCE

1. Water entering the key switch will eventually cause corrosion and could result in the starter motor being permanently energised and burning out. Spray key switch every month with WD40 or equivalent; or apply 'Vaseline'.
2. Check batteries for acid level and top up if required. For low maintenance and 'gel' batteries, please refer to the manufacturers instructions.
3. Loose spade terminal connections are the most common cause for electrical faults - check on a regular basis, please refer to 'Electrical Fault Finding' within trouble shooting.

BETAGEN ACOUSTIC ENCLOSURE

45

46

BetaGen acoustic enclosures should be kept free (internally and externally) of any contaminate spillage such as diesel fuel, lube oil or engine coolant.

With the exception of periodically checking that all of the enclosure assembly nuts, bolts, screws for tightness and all ancillary connections are secure there is no specific maintenance regime.

⚠ IMPORTANT!

Keep the enclosure air in vents free of debris, the air out duct must be vented out of the engine room.

CHECKING THE ENGINE OIL LEVEL

When checking the engine oil level, do so before starting, or more than five minutes after stopping.

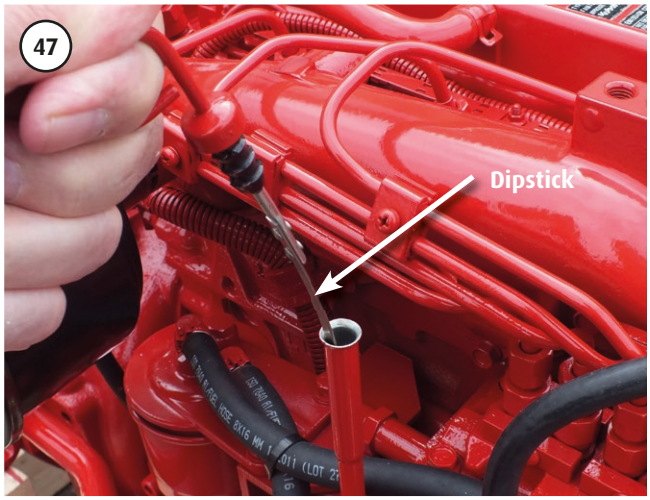
1. To check the oil level, draw out the dipstick, wipe it clean, re-insert it, and draw it out again, please refer to image 47. Check to see that the oil level lies between the two notches.
2. If the level is too low, add new oil to the engine to the specified level, please refer to image 48.

When using an oil of a different make or viscosity from the previous one, drain out the old oil. **Never mix two different types of oil.**

Engine oil should be changed after first 50 hours running time and then every year or every 250 hours if sooner.

⚠ IMPORTANT!

Over-filling your engine with oil can be as detrimental as under-filling.



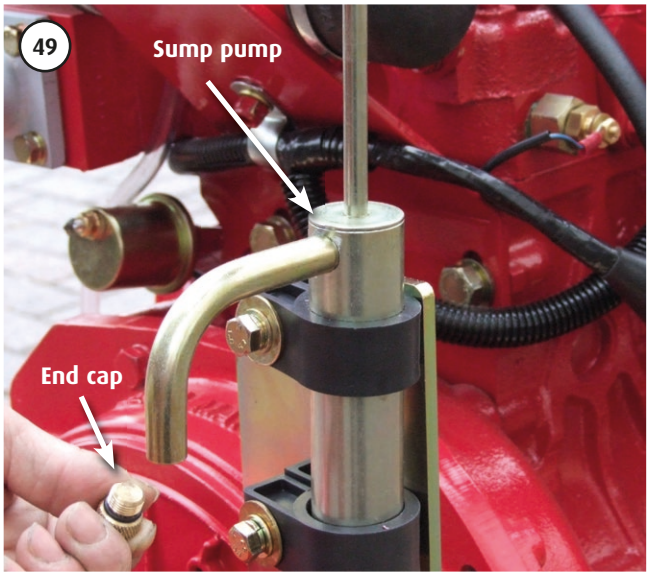
CHANGING THE ENGINE OIL

For quantities of engine oil required please refer to pages 12 to 29.

1. Run the engine for 10 minutes to warm up the oil, then stop it and open the oil filler cap.
2. Your engine is provided with a sump drain pump. Unscrew the end cap on the end of the pump spout, turn the tap to 'on'. Use the hand pump to pump out the oil into a appropriate container. Once drained turn the tap to off position and replace end cap. Please refer to image 49.
3. The oil filter is a spin on type. Remove by turning anti-clockwise when viewed face on or from below. Please refer to image 50.

NB: It is best practice to have either a drip tray or cloth wrapped round the filter to catch any oil that maybe left in the system and assist with keeping the bilge clean. Spread a thin film of lube oil around the new filter`s rubber gasket to ensure a good seal and screw in **hand tight**.

4. Fill the engine with new oil and replace the oil filler cap. Please refer to page 51.
5. Run the engine and check for oil leaks.



Sump pump location:

BetaSet-BetaGen 7, 10 & 12
Forward end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 14 & 21
AC alternator end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
Port side, heat exchanger or header tank, when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Starboard side, when viewed from the AC alternator end.

Oil filter location:

BetaSet-BetaGen 7, 10, 12, 14 & 21
Forward end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
Aft engine, starboard side, when viewed from the AC alternator end

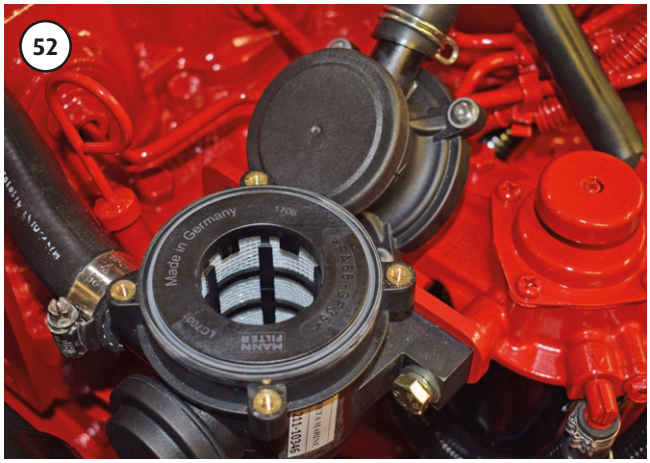
BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Forward End, port side, when viewed from the AC alternator end.

IMPORTANT! When changing the oil filter, do not allow any contaminant to enter the relief valve.

CHECKING THE CRANKCASE BREATHER - OIL SEPARATOR

BetaSet-BetaGen 40T IIIA & 49T IIIA turbocharged generating set engines are fitted with a crankcase breather - oil separator which should be inspected annually and replaced when heavily soiled.

This requires removal of the 4 cap screws and lifting it off the top of the breather main body. Reverse this procedure for re-assembly. Please refer to image 51 & 52.



FUEL FILTER REPLACEMENT

1. The fuel filter is a spin on type. Remove by turning anti-clockwise when viewed face on or from below.
2. Replace the fuel filter cartridge every 750 hours or every 2 years. Please refer to image 53.
3. Spread a thin film of diesel fuel around the new filter`s rubber gasket to ensure a good seal and screw in **hand tight**.

NB: It is best practice to have either a drip tray or cloth wrapped round the filter to catch any fuel that maybe left in the system and assist with keeping the bilge clean.

4. Bleed fuel system as detailed in 'Installation Guidelines' page 52 & 53.
5. Check for leaks.

⚠ IMPORTANT!

Keep flexible mounts free from diesel fuel, engine coolant & lubrication oil to prevent deterioration.

Fuel filter location:

HEAT EXCHANGER

BetaSet-BetaGen 7, 10 & 12
Forward end, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 14 & 21
Under air filter, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
Aft engine, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Forward end, starboard side when viewed from the AC alternator end.

KEEL COOLED

BetaSet-BetaGen 7, 10 & 12
Aft engine, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 14 & 21
Under air filter, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 26, 33, 40, 49, 40T IIIA & 49T IIIA
Aft engine, starboard side when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2, 11/2, 22/2 & 25/2
Mid engine, starboard side, when viewed from the AC alternator end.

SEA WATER PUMP AND COOLING SYSTEM

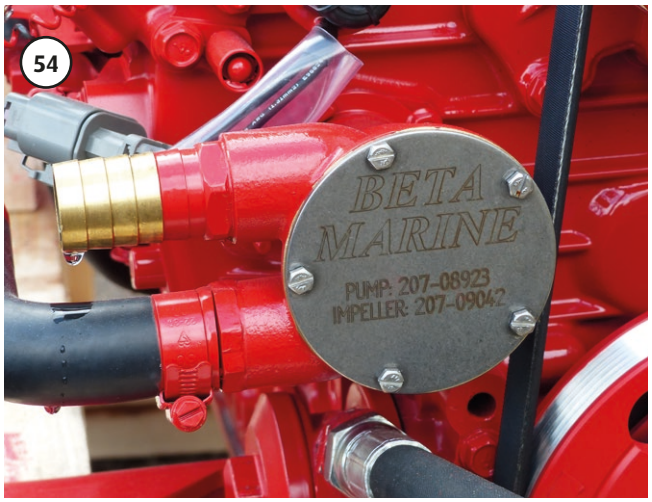
IMPORTANT!

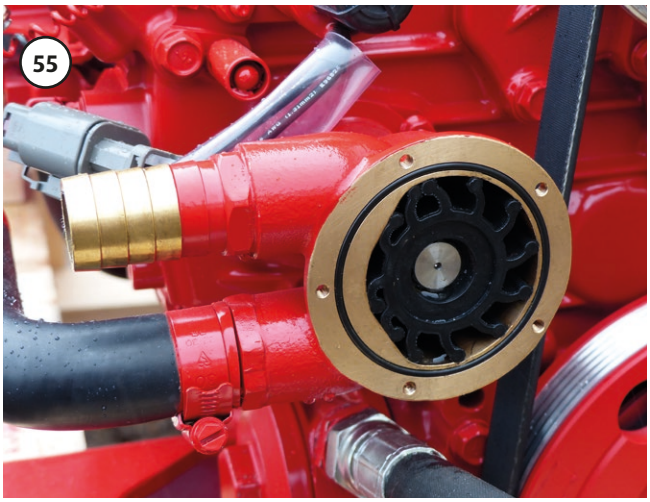
Before working on the sea water system ensure that the sea cock is in the off position.

1. It is very important that the correct sea water flow is maintained to cool the closed circuit system of the engine. The key component in this system is the sea water pump impeller. This should be checked every year by removing the circular plate. Please refer to image 54.
2. Withdraw the rubber impeller from its drive shaft as shown. Please refer to image 55. Pliers may be required.
3. Check impeller for cracks in the rubber, excessive wear or lost vanes. Replace with a new impeller as necessary. A drop of washing up liquid on the impeller will help to push it back into position.
4. If refitting the exisiting impeller make sure it's blades are facing in the same direction as they were before the impeller was removed.

NB: If any pieces of rubber impeller are missing then they must be located as they are most likely to be trapped in the entrance to, or within the heat exchanger cooling stack.

5. Run the engine up to temperature and check for leaks.





Sea water pump location:

BetaSet-BetaGen 7, 10 & 12
Mid engine, starboard side, when viewed from the AC alternator end.

BetaSet-BetaGen 14, 26 & 33
Forward end, port side, when viewed from the AC alternator end.

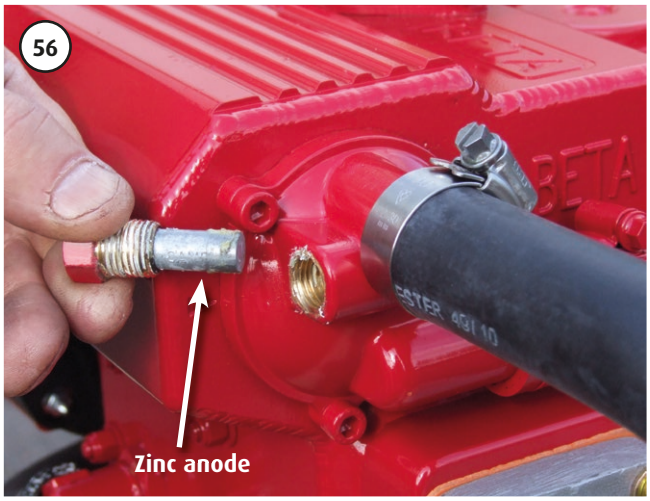
BetaSet-BetaGen 40, 49, 40T IIIA & 49T IIIA
Forward end, starboard side, when viewed from the AC alternator end.

BetaSet-BetaGen 4/2, 6/2 & 11/2
Forward end, starboard side, when viewed from the AC alternator end.

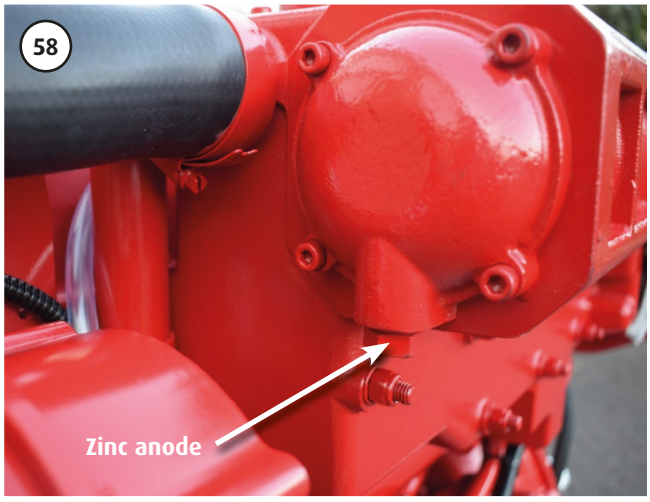
BetaSet-BetaGen 22/2 & 25/2
Forward end, starboard side, when viewed from the AC alternator end.

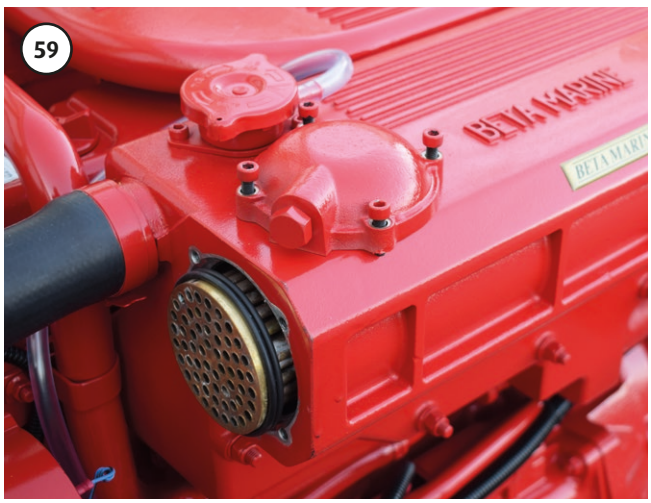
HEAT EXCHANGER TUBE STACK AND 'WASTING ZINC ANODE'

1. The wasting zinc anode should be checked regularly at least every six months and replaced every year or sooner, as necessary. The anode is attached to the bolt inserted in the end cap of the heat exchanger. Please refer to image 56. On most engines this is on the aft end.
2. Unscrew the bolt and replace the complete unit with a new one.
3. It is possible for fine sea weed and other debris to get past the inlet filter and into the tube stack. This should be removed and cleaned. Please refer to image 57.
4. Drain off coolant into a bucket.
5. Unscrew the 6 end cap retaining bolts using a 5 mm Hex key (3 each end of the heat exchanger). Remove the 'O' rings and slide out tube stack*. Carefully clean tube stack and end caps.
6. Re-assemble using new 'O' rings. The tube stack can be fitted either way around but must be aligned correctly with the horizontal line and rubber seal between the alignment marks at the exhaust end of the heat exchanger. (This ensures correct coolant flow in the heat exchanger) Do not over tighten end cap bolts. Please refer to image 57.
7. Re-fill engine with coolant (water/anti-freeze solution) and run engine up to temperature to check for leaks. Please refer 'Filling the Engine Coolant System' on page 46.

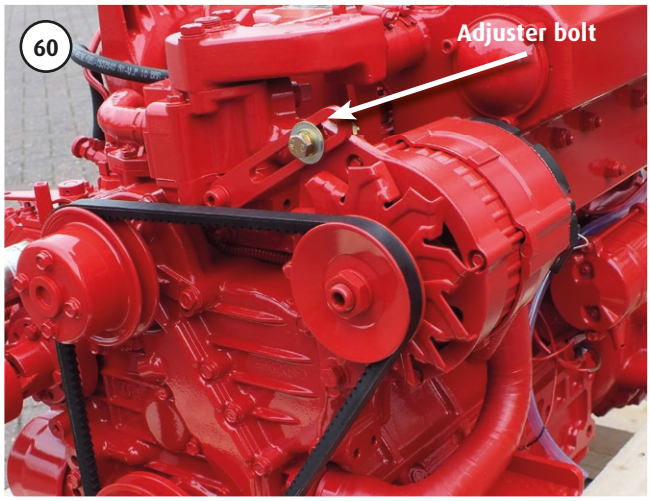


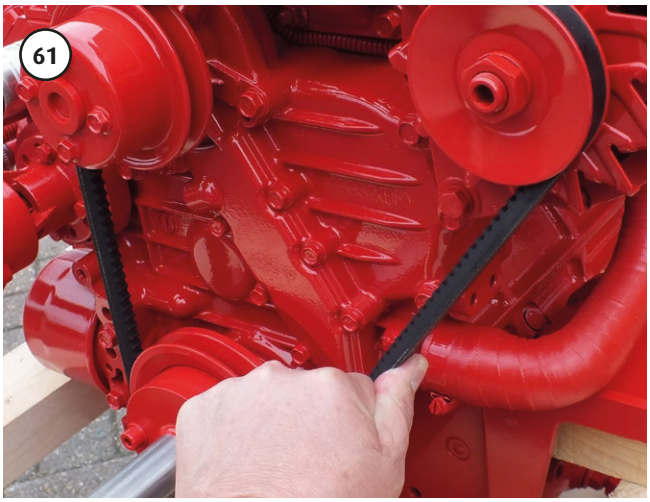
***NB:** On **BetaSet-BetaGen 40T IIIA & 49T IIIA** which are turbocharged, the anode is attached to the bolt inserted in the front gear end cap of the heat exchanger and the tube stack must be removed and replaced from the front gear end. Please refer to image 58 & 59.





DC ALTERNATOR BELT TENSION





⚠ WARNING!

Belt tension must only be checked with the engine switched off.

BATTERY CHARGING ALTERNATOR

These engines are fitted as standard with a "A" profile belt that drives both the battery charging alternator and the fresh water/engine coolant circulating pump.

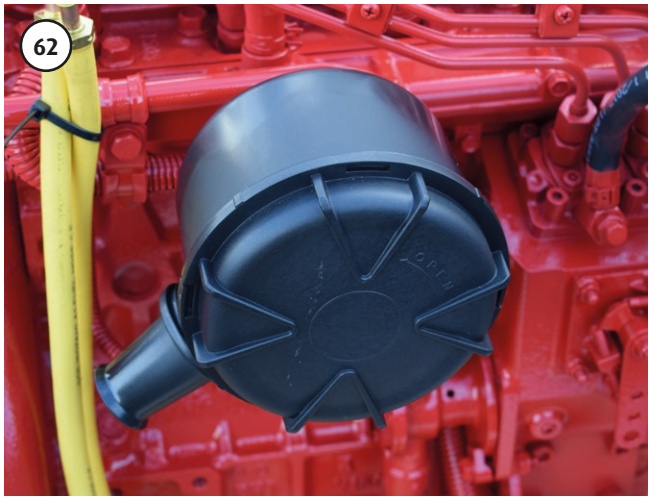
1. The belt tension is adjusted by swinging the DC alternator outboard as it pivots on its support bolts. Please refer to image 60.
2. With the engine stopped, loosen the support bolts and the link adjusting bolt.
3. Push alternator outboard by hand to tension the belt, then tighten link bolt.
4. Check that the depression of the belt (at position shown) is approximately $^1/_2$" or 12 mm when pushed down firmly by thumb. Tighten support bolts. Please refer to image 61.
5. Belt tension should be regularly checked especially during the first 20 hours of running in a new belt, as stretching occurs.

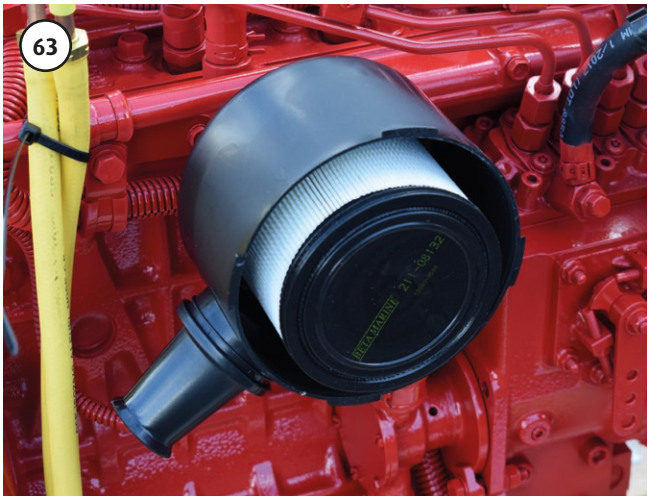
⚠ IMPORTANT!

Tension drive belts by hand only, do not over tension.

AIR FILTER

These engines are fitted with a replaceable air filter which should be inspected annually and replaced every 2 years or sooner if heavily clogged. If this occurs increase inspection frequency.



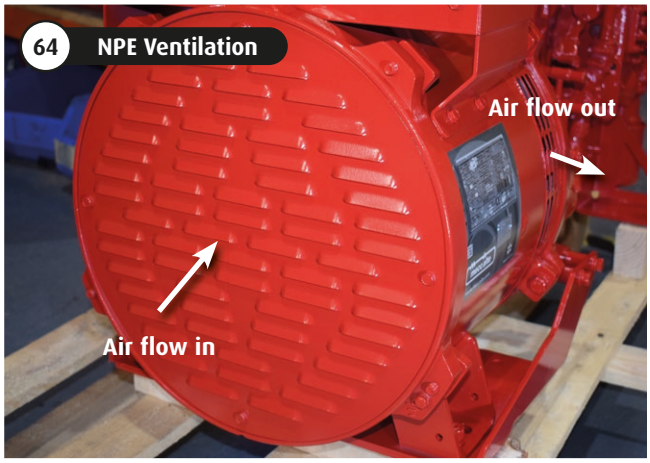


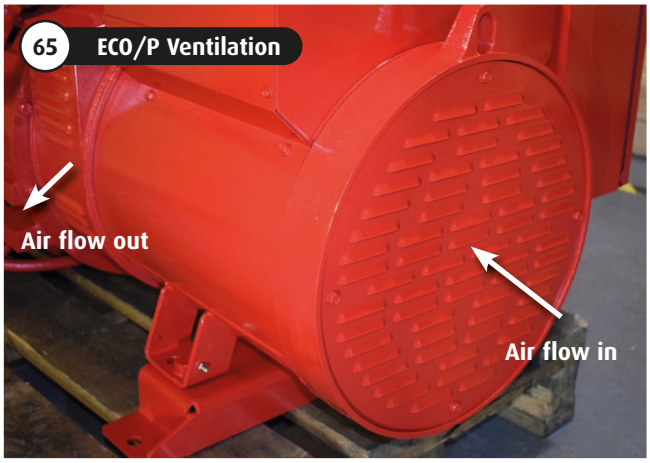
GENERATOR ALTERNATOR VENTILATION

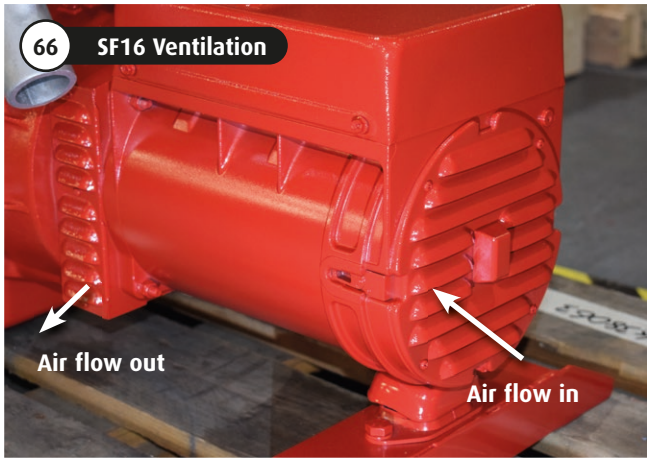
Mecc Alte AC alternator, air in and air out vents should be kept clean and clear of debris to ensure efficient airflow is maintained.

IMPORTANT!

Do not attempt this whilst the generator set is in use, only when it is has been stopped and fully cooled down.







IMPORTANT!

BetaGen set variants must have there air flow out ducted out of the engine room.

AC ELECTRICAL MAINTENANCE

WARNING! ELECTRICITY IS DANGEROUS AND CAN CAUSE DEATH IF THE GENERATING SET IS NOT CORRECTLY INSTALLED, MAINTAINED AND USED

Maintenance should only done by a qualified/certified electrician.

IMPORTANT!

Refer to the independent AC alternator manufacturer's operator manual originally supplied with the generating set. If required, replacement AC alternator PDF files can be be downloaded from our website: www.betamarine.co.uk

Always ensure that the 12v DC & AC circuit have been isolated before performing any maintenance.

WINTERISING AND LAYING UP

a) The engine lubricating oil and lubricating oil filter should be changed at the end of the season rather than in the spring. Please refer to 'Section 2'.

b) The closed circuit cooling system must contain an anti-freeze coolant solution. The coolant solution is a mixture of fresh water and anti-freeze (Mono Ethylene Glycol based conforming to BS6580:1992) with the anti-freeze being a 50% solution (this also applies to warm and tropical climates). The warranty is invalid if the correct percentage/ratio is not used.

c) For cold climates where the air or water temperatures can fall below 3°C, the sea water circuit must be protected in addition to the fresh water system. This is best achieved as follows:

- Close the inlet seacock to the engine (engine stopped).
- Disconnect the sea water inlet pipe and dip it into a small bucket containing 50:50 anti-freeze solution.
- Start the engine and run for 5 to 10 seconds until the anti-freeze is used up and can be seen coming out of the exhaust outlet.
- Shut engine off and reconnect the inlet pipe to the seacock. The sea water or raw water circuit is now protected by anti-freeze.

d) Ensure instrument panel is well protected and give the key switch a spray of WD40/Petroleum Jelly or equivalent.

e) With the engine stopped, disconnect the battery (always disconnect the negative cable first and re-connect the negative cable last) top up and trickle charge as appropriate.

f) Fuel tanks should be kept full during the lay up period to eliminate water condensation in the tank. Water entering the fuel injection system can cause considerable damage.

LAYING UP ASHORE

a) Change the engine oil before the vessel is taken out of the water as warm engine oil is much easier to remove than cold.

b) Cooling system - As above in 'Winterising and Laying Up' paragraphs (b) to (f) should be followed.

c) If the engine is to be laid up for more than 6 months then remove the sea water pump impeller - heat exchanger cooled only.

d) If the engine will not be used or run for periods longer than 6 months we recommend that the engine is 'inhibited' - this involves running the engine for about 5 minutes to:

- Replace all the diesel fuel in the fuel system and injection pump by running the engine with 'calibration fluid' (fuel pump test oil ISO 4113).
- Allow 'Ensis' to circulate around the lubricating oil system by draining out the standard lubricating oil and replacing it with a rust preventative oil such as 'Ensis' or similar.

Section 4: Trouble Shooting

ENGINE TROUBLE SHOOTING

Beta diesels are very reliable if installed and serviced correctly, but problems can occur and the following list gives the most common ones and their solution.

Problem: Engine does not start but starter motor turns over OK

Possible Cause	Solution
No fuel:	Turn fuel cock on and fill tank.
Air in fuel system:	Vent air (please refer to 'Bleeding the Fuel System' on page 52 & 53).
Water in fuel:	Change fuel filter, check fuel/water separator and bleed the fuel system.
Blocked fuel pipe:	Clean out and bleed the fuel system.
Fuel filter clogged:	Change filter and bleed system.
Fuel lift pump blocked:	Remove and replace.
Blocked injector:	Remove and clean.
Fuel return not fed back to the tank:	Re-route fuel return pipe.
Heater plugs not working:	Check wiring to the plugs, and replace plugs if they have burnt out.
Stop solenoid stuck in off position:	Check solenoid is free to return to the run position.

Problem: Starter motor will not turn or turns over very slowly

Possible Cause	Solution
Battery discharged:	Charge battery or replace. Check alternator belt tension.
Starter motor flooded with sea water:	Remove and clean, or replace.
Wiring disconnected or loose:	Check circuit for loose connections.
Water in cylinders:	Check engine oil for signs of water (creamy-coloured oil). If found do not attempt to start the engine, contact your dealer or service agent.
Engine harness fuse blown:	Replace fuse located by starter motor (or above flywheel housing) and check for wiring faults.
Oil switch faulty or disconnected:	Check loom, connection blocks and switch, repair or replace as necessary.
Engine starts but stops after 3 seconds:	DSE modules - fuse blown in AC alternator or oil switch faulty.

Problem: Low power output

Possible Cause	Solution
Blocked fuel filter:	Replace.
Blocked air filter:	Replace.
Air in fuel system:	Check system and bleed.
Governor spring incorrectly mounted:	Dealer to adjust.
The electrical load is too large on start up:	Disconnect or reduce the load.

Problem: Erratic running/hunting

Possible Cause	Solution
Air in fuel supply:	Check supply system for leaks and fix.
Fuel lift pump faulty:	Replace.
Clogged fuel filter:	Replace.
Fuel return not fed back to the fuel tank, or blocked pipe:	Re-route pipe or clean.
Air filter blocked:	Replace.
Worn or blocked injector:	Service injectors.
Engine rpm in gear is too low, this must be 850 min:	Increase engine tick over speed.
Faulty stop solenoid:	Disconnect wiring to solenoid. If running improves check for a wiring fault.
Broken fuel injection pump spring:	Replace, this is usually caused by water in the engine oil/fuel.
Fuel suction head is too great:	Fit electric fuel lift pump.

Problem: Hunting

Possible Cause	Solution
Fuel supply problem:	Change fuel filter and check fuel supply.

Problem: White or blue exhaust gas

Possible Cause	Solution
Engine oil level too high:	Reduce the level.
Blocked injector:	Service injectors.
Piston ring and bore worn or con rod bent due to water ingression, giving a low compression:	Get the compression checked by your dealer or service agent. They will advise action to be taken.
Check that the breather pipe is clear and not obstructed:	Remove and clean out.

Problem: Black exhaust gas

Possible Cause	Solution
Blocked air filter element:	Inspect and replace.

Problem: High oil consumption

Possible Cause	Solution
Oil leaks:	Check for leaks.
Piston rings worn:	Overhaul required.
Valve stem and guide worn:	Overhaul required.
Piston rings gap facing the same direction:	Shift ring gap position. Dealer or service agent to check.

Problem: Water in lubricating oil - general

Possible Cause	Solution
Core plug pushed out due to frozen block:	Dealer or service agent to check and replace.
Water pump seal damaged:	Dealer or service agent to check and replace.

Problem: Water in lubricating oil - heat exchanger cooled

Possible Cause	Solution
Oil goes “milky” due to seawater entering exhaust manifold:	Check installation - has an anti-syphon valve been fitted? Change engine oil and run engine for 10 minutes each time to eliminate any water. Get fuel injection pump and compression checked by dealer or service agent.

Problem: Water in lubricating oil - keel & radiator cooled

Possible Cause	Solution
Oil goes “milky” due to water entering exhaust manifold and then into the sump:	Check installation - has the dry exhaust system been fitted correctly, ensuring rain water cannot enter the exhaust port and run back? (please refer to ‘Dry Exhaust System on page 40). Change engine oil and run engine for 10 minutes each time to eliminate any water. Get injection pump checked by dealer or service agent.

Problem: Engine overheats - general

Possible Cause	Solution
Check coolant level:	Top up.
Pressure cap loose:	Tighten correctly or replace.
Switch sender faulty:	Replace.
Insufficient restrictions in pipe to calorifier:	Clamp off pipe to confirm.
High exhaust back pressure:	Must not exceed the information given in 'Exhaust Back Pressure' in the installation section.

Problem: Engine overheats - heat exchanger cooled

The most common cause of overheating is insufficient seawater flow due to a blocked intake. If this happens first clear the debris, causing the blockage. If the problem is not cured then check the system for sea water flow which should be 13 - 14 litres/minute minimum at 1,500 rpm.

(a) With the vessel moored run the generating set engine. Hold an appropriate container under the exhaust outlet for 10 seconds and measure the amount of water collected*. Multiply this value by 6 to give the flow in litres/minute. Repeat twice and take an average. If the flow rate is noticeably less than the 13 - 14 litres/minute minimum, then:

(b) Check the impeller within the sea water pump - if worn replace.

(c) If any pieces of rubber impeller are missing then they must be located as they are most likely to be trapped in the entrance to, or within the heat exchanger cooling stack.

(d) Check flow again as in (a).

***NB:** This operation must only be done in safe conditions, in port with assistance. Always use appropriate personal protective equipment, risk assess handling hot water and exposure to exhaust gas emissions.

Problem: Engine overheats - keel & radiator cooled

Commonly overheating is caused by:

(a) Not fully venting the engine cooling system of air. It is necessary to remove all air from the cooling system - including the 'skin' (radiator) tank/s and (if fitted) the Calorifier and associated piping.

(b) Keel cooled, are the vessels skin tank/s adequately sized for using maximum engine power on fast flowing rivers or estuaries?

NB: Skin tanks originally intended for canal use only may be sized with the vessel being over propped and not using maximum engine output as part of the calculation. Should this be the case, an additional or enlarged skin tank may be required if maximum output is required. For further information please visit: www.betamarine.co.uk

Problem: Vibrations

Possible Cause	Solution
Flexible mounts not adjusted correctly to take even weight:	Check relative compression of each mount.
Flexible mount rubber perished:	Replace, diesel or engine oil will eventually perish rubbers.
Loose securing nut on flexible mount:	Check alignment and then tighten the nuts.
Weak engine support/bearers:	Check for cracked or broken feet.

Problem: Knocking noise

Possible Cause	Solution
Flexible mount stud touching engine bed:	Adjust stud to clear.
Drive plate broken:	Replace/repair.
Engine touching engine bed:	Re-align engine/modify bed.
Injectors blocked through excess carbon caused by water in the fuel:	Remove and check injector nozzles, replace if required.

Problem: Battery quickly discharges

Possible Cause	Solution
High load and insufficient running:	Reduce load or increase charging time. Large domestic battery banks subject to high electrical loads will take a considerable time to recharge from a single alternator.
Low electrolyte level:	Top up.
Fan belt slipping - black dust in engine compartment, engine compartment temperature too high:	Adjust tension/replace belt with a high temperature type and/or improve engine compartment ventilation.
Alternator defective:	Check with dealer or service agent.
Battery defective:	Replace.
Poor wiring connection:	Check wiring system.

GENERATING SET TROUBLE SHOOTING

No Electrical Output

Very small generating sets may occasionally fail to give power output against some electronically controlled loads. This however is very infrequent due to the 'skew' wound AC alternators Beta Marine specify. Should this be experienced please contact Beta Marine.

Should a generating set that has been previously been functioning satisfactorily fail to give output or provide a low voltage output it is often the result of welding taking place on board or other external electrical influence. Which under some circumstances may cause the AC alternator to loose residual magnetism which will prevent it from powering up.

To rectify a qualified/certified electrician should refer to the independent AC alternator manufacturer's operator manual originally supplied with the generating set and follow the instructions for:

'Check of residual voltage' and 'Alternator does not excite'. These processes are known as 'field flashing'.

For all other AC alternator fault finding and maintenance, please refer to the independent AC alternator manufacturer's operator manual originally supplied with the generating set.

ELECTRICAL TROUBLESHOOTING - GENERAL OVERVIEW

Before investigating any specific electrical problem, always check:

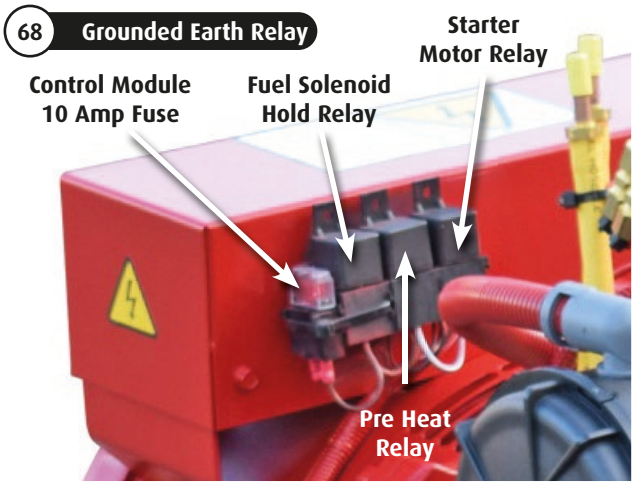
- The starter battery is connected to the correct terminal on the starter motor.
- Battery connections and inspect the condition of the cables from the battery to engine. Measure the voltage at the engine.
- The battery isolation switch is to the '**ON**' position.
- The 10 amp engine harness fuse to see if it has blown - replace and **check all** DC wiring for faults.
- If there is a starter alternator charge problem, measure battery voltage with engine off and again with engine running, if there is an increase the battery alternator is functioning correctly.

CONTROL MODULE TROUBLE SHOOTING

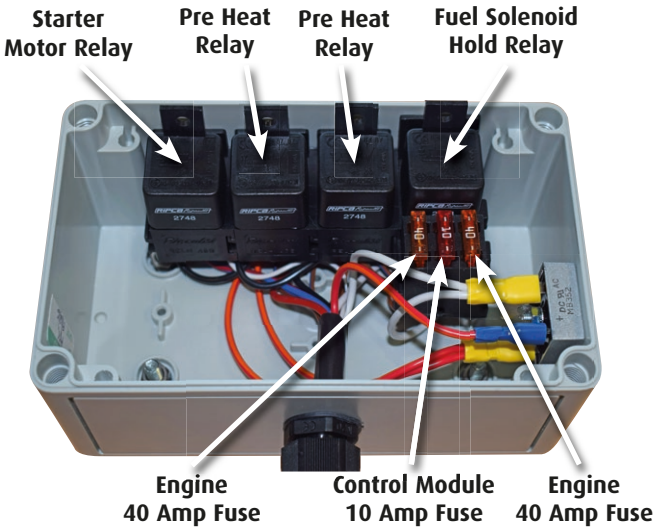
Problem	Possible Cause and Solution
Control module, DC on and charge fail light not lit, generating set will not start:	• Check for battery supply on engine starter B+ (battery positive) and battery negative using a voltmeter set to read DC. • Check for poor ground connections on all engine harness black wires, switch the starter battery off to check continuity to engine ground for all of these black wires. • Check for battery supply on the engine harness 11 way plug, terminal 4 (brown fused B+) and 6 (black B-). Note: There are two small brown wires in this plug, check terminal 4 connection only. • Check for battery supply on module terminals 4 (B+) and 6 (B-) using a voltmeter set to read DC.
Generating set will not start, pre heat light illuminates (PSM720 only) **NB:** Although the EPM72, RSM72 & LSM72 do not have a pre heat warning light all modules do have a programmed pre heat function and all will require the same fault check process.	• Pre Heat timer function is over timed, check the setting screw on the pre-heat timer at the rear of the module and adjust to approximately < 6 seconds maximum.
Generating set will not start, oil pressure light not illuminated:	Low oil pressure is not sensed, check oil pressure switch connections, refer to the relevant engine / module wiring diagram/s within Section 5 Diagrams.
Generating Set starter motor turns but the engine does not start:	Fuel solenoid not energising: • Check wiring to fuel solenoid, blue/red to hold coil, white/red to pull coil, (black to ground if required on solenoid). • Remove solenoid and check it is free to return to run position. • Faulty fuel solenoid, identify mechanical stop lever first, this will have to be activated to stop engine. Then remove the fuel solenoid to see if this allows the engine to run. Stop engine and replace faulty fuel solenoid.

Problem	Possible Cause and Solution
Generating Set engine stalls after initial start up - Fuel solenoid not holding:	• Check solenoid hold relay, please refer to image 69. Temporarily swap this relay with the pre heat relay, try to restart the generating set after resetting all shutdowns. If the generating set now runs, replace the faulty relay with a new relay. Or • Measure DC voltage on relay blue/red hold wire. Best practice is to inhibit the generating set engine from starting by temporarily removing the red/white connection from the starter solenoid, then follow the normal start-up procedure, through engine pre heat, fuel solenoid energise, to solenoid hold state. At this point there should be 12v measured on the hold wire for the engine to continue running after start-up. If the voltage is correct, replace fuel solenoid with new.
The generating set engine does not start but starter is engaging and the fuel solenoid is energising:	• No fuel, check the fuel tank/level and that the fuel cock is turned to the on position. • Air in the fuel system, vent air, please refer to 'Bleeding the Fuel System'. • Water in the fuel, change the fuel filter and bleed the fuel system. • Fuel filter clogged, change the fuel filter and bleed the fuel system. • Fuel lift pump (if fitted) blocked, remove, replace and bleed the fuel system. • Fuel return not fed back to tank, re-route fuel return pipe.

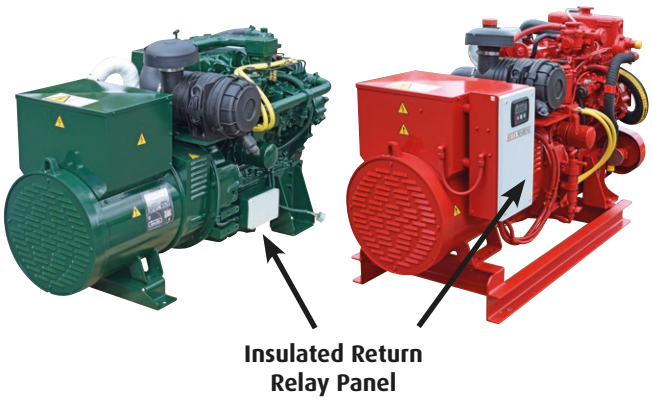
68 Grounded Earth Relay



69 Insulated Return Relay

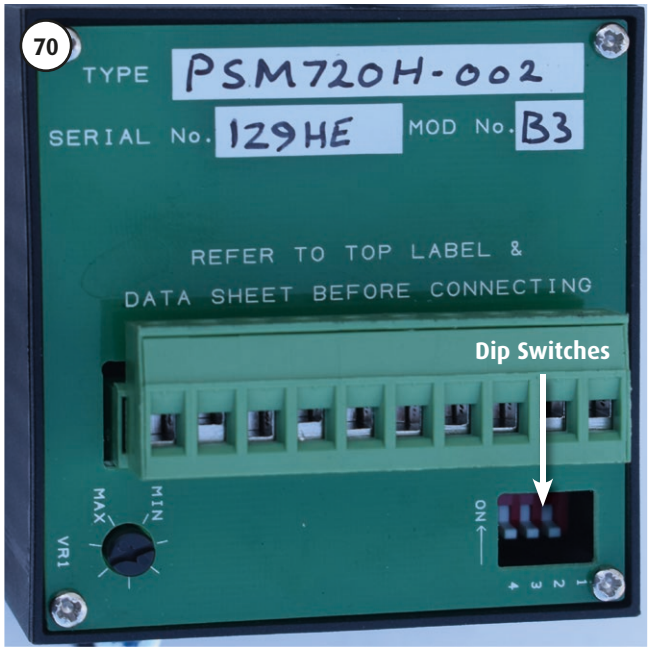


Insulated Return Relay Panels will be mounted in the following areas:



Problem	Possible Cause and Solution
The generating set engine doe not start but turns over very slowly and or stops:	• Starter battery is discharged, charge or replace, check that the DC alternator belt is correctly tensioned. • Starter motor ingressed by moisture/water, remove and clean or replace. • Water in cylinders causing hydraulic look – Incorrect Heat Exchanger installation or continuous cranking with the sea cock open. Check lube oil for signs of water, do not attempt to start engine. Get the engine checked by a dealer or service agent.
The generating set engine pre heat is not operating:	• Time the duration of the programmed pre heat, engine not cranking period is correct > 6 seconds maximum. • Check connections on the engine harness to preheat relay and on to engine heaters (red wire). • Check the pre heat relay. Best practice is to inhibit the generating set engine from starting by temporarily removing the red/white connection from the starter solenoid. Measure the voltage on heaters to ground with a voltmeter set to read DC. If it reads as being close to 12v the relay is functioning correctly. If no voltage is measured, temporarily swap the start relay with the heat relay. Measure the voltage again on heaters. If voltage is now measured, replace the original faulty heat relay with a new relay.

ENGINE START UP - PSM MODULE ONLY

Problem	Possible Cause and Solution
PSM720 Only - Oil pressure light illuminated  	• Incorrect dip-switch settings. All dip-switches at the rear of the module, bottom right hand side must be on the '**OFF**' position. • The green '**START**' button has only pressed once, for power up and preheat, the engine will not crank unless it is pressed a second time and held for no more than 9 seconds.

SHUT DOWN ON FAULT

Problem	Possible Cause and Solution
Low oil pressure shutdown - Oil pressure light illuminated:	• Check the engine oil system for leaks & top up if required. • Blocked lube oil filter, replace. • Oil relief valve stuck partially open with dirt, remove and clean. • Faulty oil pressure switch.
High engine temperature shutdown - High engine temperature light, illuminated:	• Allow generating set to cool down. Check engine coolant level, top up appropriately, refer to 'Filling the Engine Coolant System'. • Heat Exchanger, Header Tank or Radiator pressure cap, check that it is not loose or faulty, replace cap should it be required. • High exhaust back pressure, must not exceed the stated back pressure by 3" of Hg. • Check/test the engine water temperature switch, if faulty replace.

HEAT EXCHANGER GENERATING SETS

Problem	Possible Cause and Solution
High engine temperature shutdown - High engine temperature light, illuminated:	• Incorrect dip-switch settings. All dip-switches at the rear of the module, bottom right hand side must be on the '**OFF**' position. Please refer to image 70.
High engine temperature shutdown - High engine temperature light, illuminated:	• Is the sea water inlet sea cock diameter correct? please refer to the chart within 'Sea Water Inlet for Heat Exchanger Cooled Engines'. • Check that the sea cock is fully opened and that the sea water intake and/or filter are not blocked, causing insufficient sea water flow. • Check the the seawater pump impeller is not worn or damaged, replace should it be required. If the impeller has a vane missing it will be lodged either in the pipe leading to the heat exchanger or within it, this must be located and removed*. • The tube stack within the heat exchanger may be blocked*, remove the tube stack, clean and re-assemble, always using anew pair of replacement O ring seals. Please refer to 'Heat Exchanger Tube Stack & Wasting Zinc Anode'.
The generating set DC battery charging alternator fails to excite - Battery charge light illuminated:	• The ignition connection on the DC alternator (small brown wire from the DC alternator to the 11 way connection plug terminal 9) is not connecting to the module socket terminal 7. Inspect the connections and check continuity of this wire. • The charge fail connection on the DC alternator (small brown/black wire from the DC alternator to the 11 way connection plug terminal 7) not connecting to module socket terminal 8. Inspect the connections and check continuity of this wire.

ELECTRICAL TROUBLE SHOOTING - EXTENSION HARNESSES

Some installations require one of the 'panel extension 11-way connectors' to be removed to allow the cable to be passed through bulkheads etc.

If any panel problems are experienced, after this has been done, visually check all 11-way connections on engine harness to panel extension* to ensure wire colours to each terminal match up to the correct colour in its corresponding terminal.

Extra attention must be given to black (ground) and black/blue (tacho), also brown (switched positive to alternator) and brown/yellow (charge fail) as these connections are harder to distinguish between in poorly lit areas. Whilst doing this check integrity of each connection to ensure terminals have not become damaged. Once checked, re-fit cable tie around each connection to keep them secure.

* Also applies for panel to panel extension cables for installations with additional flybridge control panel option.

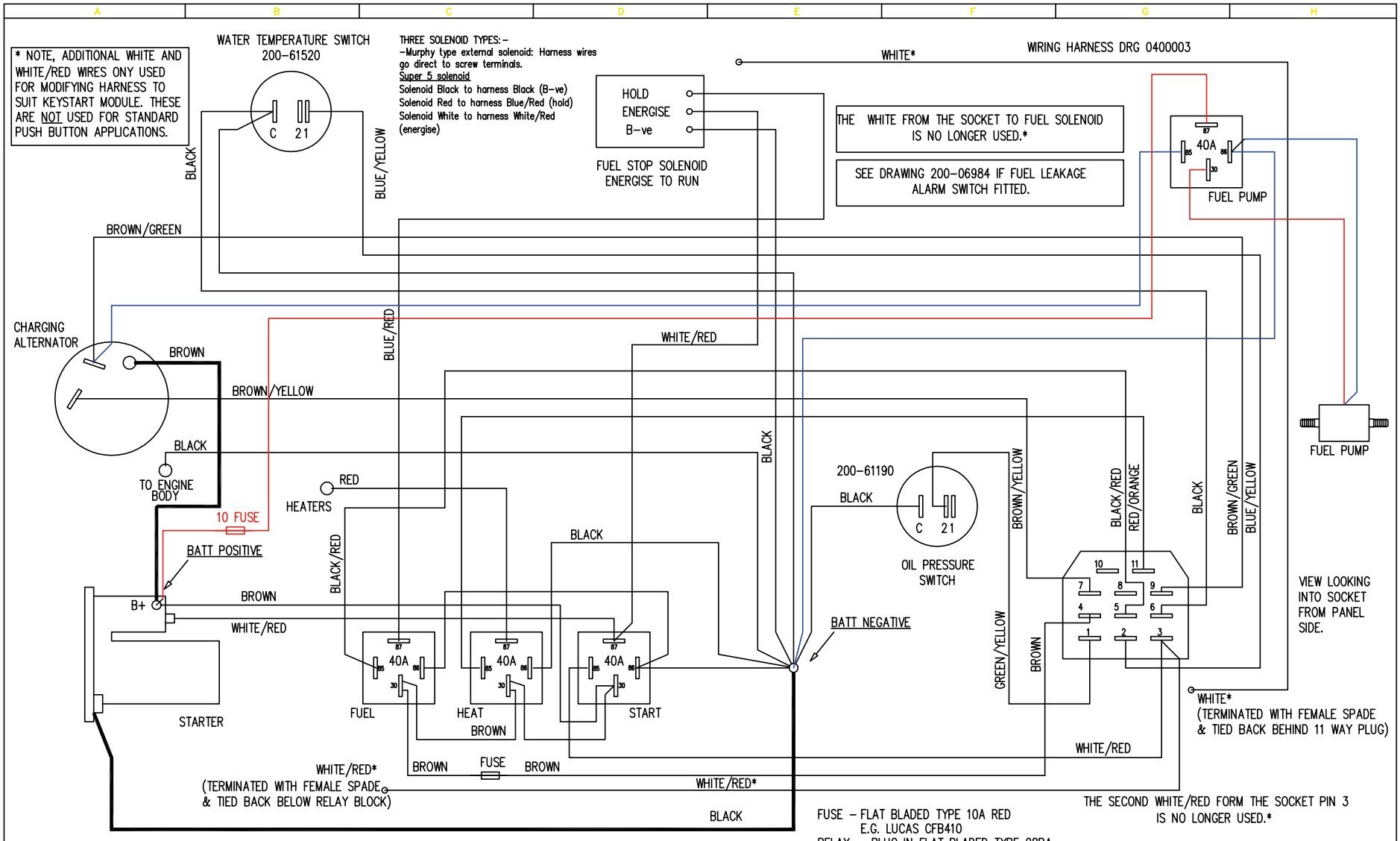
ELECTRICAL TROUBLE SHOOTING - INSULATED EARTH

If your application is wired as insulated earth return and the engine will not operate correctly, always check starter battery negative is connected to the correct terminal on the isolating solenoid.

It should be connected to the terminal which is also used for all the small black wires. **NB:** Not the terminal with the single black wire connected directly to engine ground.

Section 5: Diagrams

NB: Further information and arrangement drawings can be found on our website at: **www.betamarine.co.uk**



REV	MODIFICATION	No.	DATE	CHECKED
01	SOLENOID TEXT UPDATED		23/03/04	DM
02	WIRES AND TEXT UPDATED		13/09/04	DM
03	MOVED WHITE/RED WIRE		26/10/05	DM
04	CHANGED WIRE COLOURS		19/05/09	DM
05	ADDED TEXT TO RELAYS		05/03/10	DM
06	CHANGED WIRE CONNECTION		18/11/13	DM

DESCRIPTION

GROUNDED 2 WIRE ELECTRICS FOR KUBOTA GENSETS FOR USE WITH PUSH BUTTON START MODULE. STANDARD

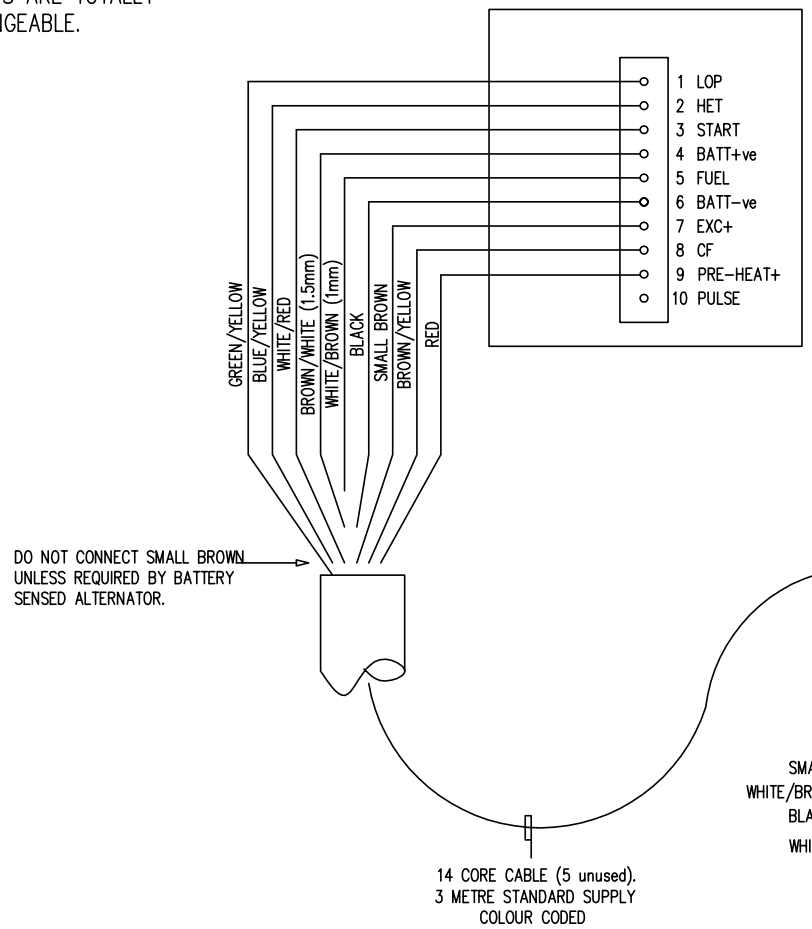
SCALE	
DRAWN	P.A.G.
ENG.	P.A.G.
CHECKED	

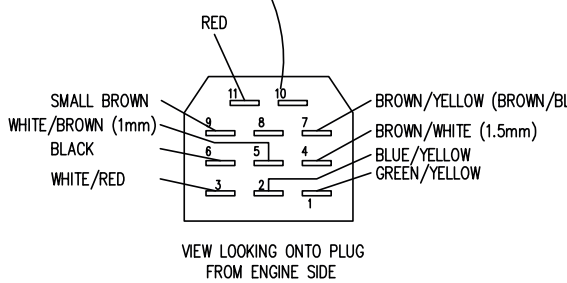
BETA MARINE

DATE	FILE No.	DRG No.	REV
01.04.2003	FIRST USED ON K11714	200-05647/E SHT 1 OF 1	06

PUSH BUTTON START MODULE WITH HOUR METER COMBINED.
PSM72H – BETA PART NUMBER 200–03316.
PSM720H – BETA PART NUMBER 200–06116.

THE PSM72H HAS BEEN REPLACED BY THE PSM720H. BOTH UNITS ARE TOTALLY INTERCHANGEABLE.





– ENGINE IS PRE–WIRED USING WIRING HARNESS 300–85450 WHOS CIRCUIT IS DETAILED ON DRAWING 200–05647, OR ON DRAWING 200–05694 IF INSULATED RETURN WIRING.

– CUT OUT REQUIRED IN MOUNTING PANEL FOR START MODULE 66 x 66mm & CLEARANCE DEPTH REQUIRED AT LEAST 100mm.

– * TERMINAL 7 ON START MODULE IS TO FEED POWER TO 'BATTERY–SENSED' CHARGING ALTERNATORS (LIKE KUBOTA STANDARD). IN THIS EVENT USE SMALL BROWN CORE.

TO START: PRESS GREEN BUTTON MOMENTERILY TO POWER UNIT UP. AS SOON AS PRE–HEAT LED HAS EXTINGUISED PRESS AND HOLD GREEN BUTTON UNTIL ENGINE FIRES. RELEASE BUTTON.
THE MODULE INCORPORATES OVERCRANK PROTECTION. IF ENGINE FAILS TO START WAIT 10 SECONDS AND TRY AGAIN. AFTER 3 ATTEMPTS PRESS RED BUTTON TO POWER THE UNIT DOWN.

TO STOP: PRESS RED BUTTON.

WIRES IN LOOM NOT USED FOR STANDARD SET–UP:
BLACK/BLUE
GREEN/BLUE
YELLOW
VIOLET
WHITE/BLACK

REV	MODIFICATION	DATE	CHECKED
03	WIRE COLOURS	15.03.10	DM
02	PSM720H ADDED	13.08.08	PAG
01	INSULATED RETURN DRG NO ADDED.	20.05.03	PAG

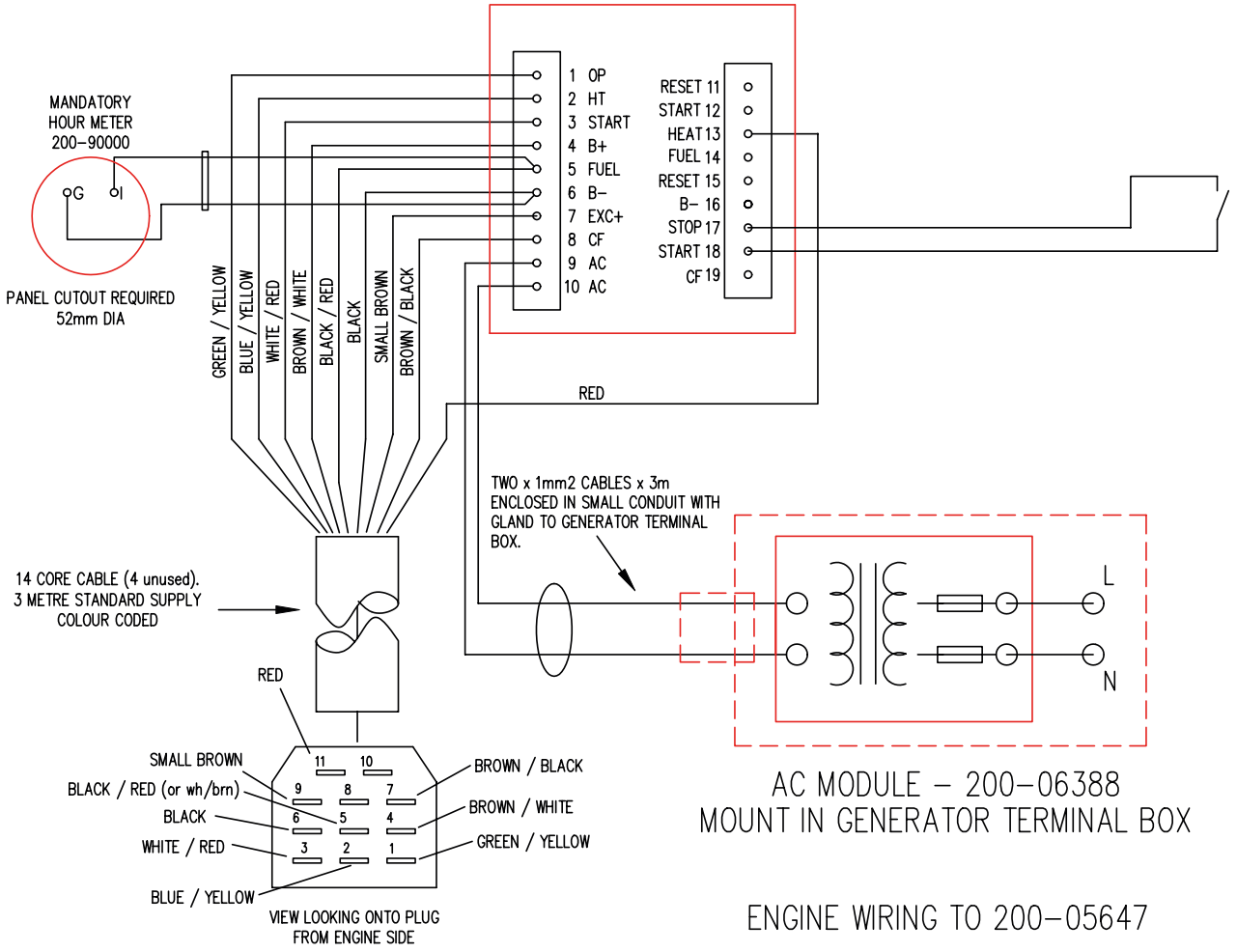
DESCRIPTION: PUSH BUTTON START CONNECTIONS FOR KUBOTA GENSETS – STANDARD.

SCALE
DRAWN P.A.G.
ENG. P.A.G.
CHECKED
DATE 01.04.2003

BETA MARINE

FILE No. P/740
DRG No. 200–05646 SHT 1 OF 1
REV 03

RSM MODULE FOR LOCAL INSTALLATION.
RSM72A/X136, 200-06846 (+ve pre-heat)



AC MODULE - 200-06388
MOUNT IN GENERATOR TERMINAL BOX

ENGINE WIRING TO 200-05647

RSM HAS KNOB CONTROL, OFF - AUTO - MANUAL. FOR MANUAL START SELECT MANUAL AND WAIT FOR RSM TO START ENGINE THROUGH ITS CONTROL CIRCUITS.

CUSTOMERS REMOTE START / STOP SIGNAL.
CLOSE TO START, OPEN TO STOP WHEN AUTO SELECTED.
This could the the volt free contact of a battery sense unit such as our 200-03926.

MOUNTING OF RSM MODULE -
CUT OUT 66 x 66mm. CLEARANCE DEPTH FOR RSM AT LEAST 160mm.

This is suitable for engines normally controlled with a push button start module. The RSM is a direct replacement but note the extra depth required.

SEE SHEET 2 FOR MPU SENSE.

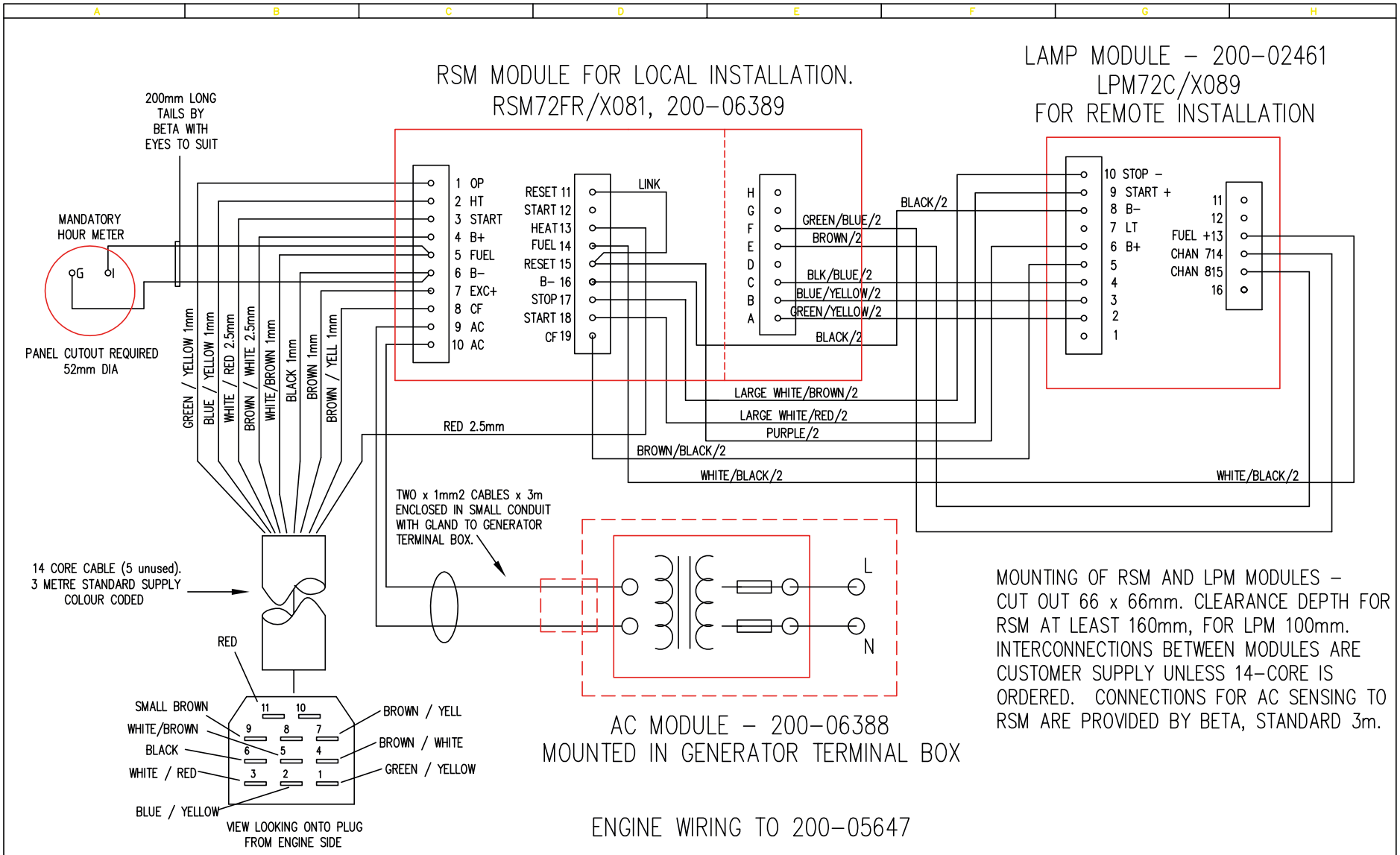
REV	MODIFICATION	DATE	CHECKED

TITLE: REMOTE START CONNECTIONS FOR KUBOTA GENSETS, GROUNDED. AC SENSE.

SCALE	N/A
DRAWN	P.A.G.
ENG.	P.A.G.
CHECKED	

BETA MARINE

DATE	27.07.2006	FILE No.	KS	DRG No.	200-06847 1 OF 2	REV	00

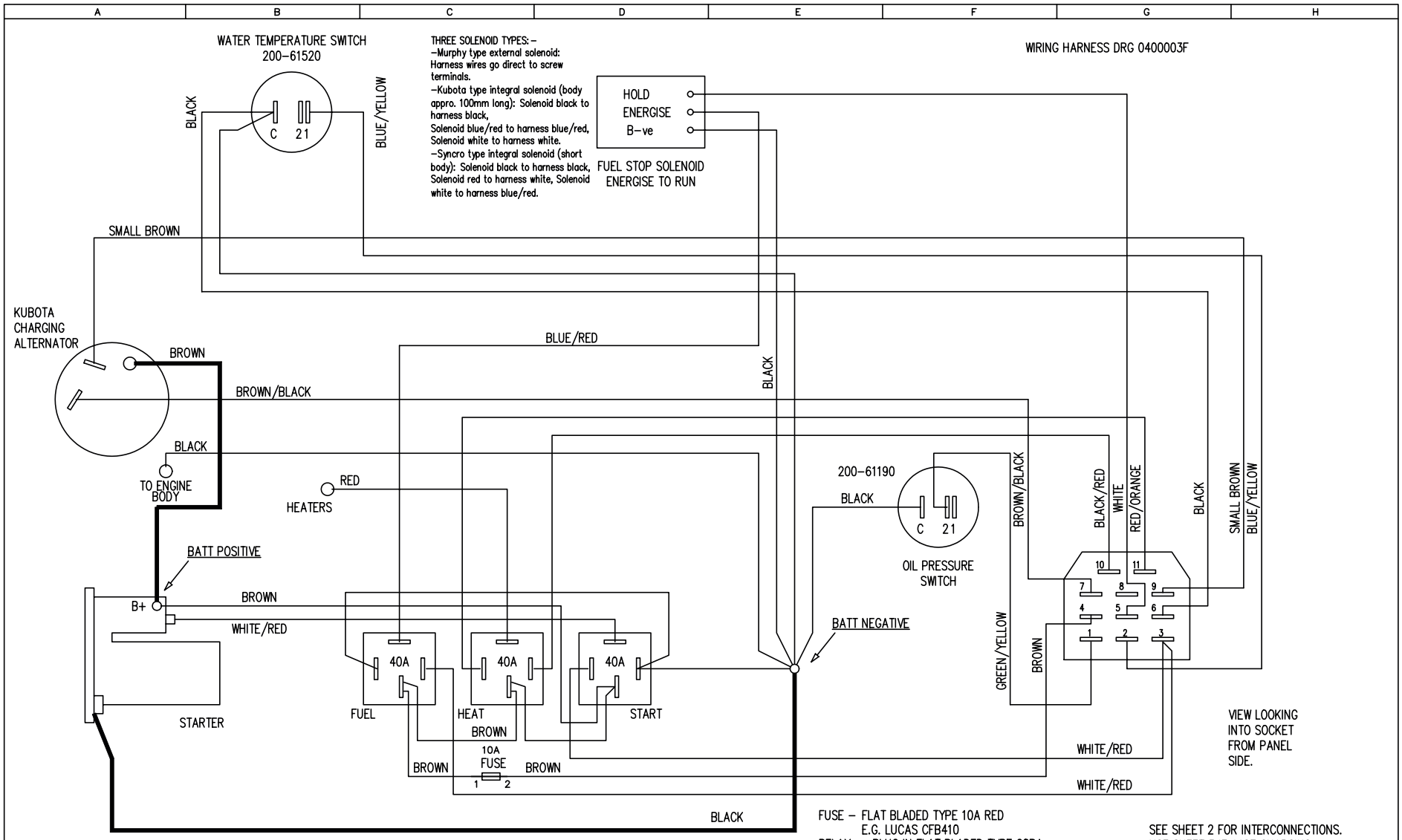


REV	MODIFICATION	DATE	CHECKED
01	PRODUCTION MODS, DM email 27/9	27.09.2010	PAG

TITLE: REMOTE START CONNECTIONS FOR KUBOTA GENSETS, GROUNDED.

SCALE	N/A
DRAWN	P.A.G.
ENG.	P.A.G.
CHECKED	
DATE	26.01.2005
FILE No.	
DRG No.	200-06387 1 OF 1
REV	01

BETA MARINE



REV	MODIFICATION	No.	DATE	CHECKED
12	RELAYS MOVED		APR 02	DM
11	NOTE RE SOLENOID ADDED		JUL 99	
10	DIODES REMOVED - ONLY REQUIRED WITH 2ST		APR '97	
09	KUBOTA ALTERNATOR ADOPTED AS STANDARD		NOV '96	
08	HOUR METER REMOVED TO SHEET 2. QA023		APR '96	
07	OPTIONAL HOUR METER SHOWN		FEB '96	
06	ALL RELAYS NOW 40A		OCT '95	
05	RE-DRAWN - COLOUR CODED		JULY '95	

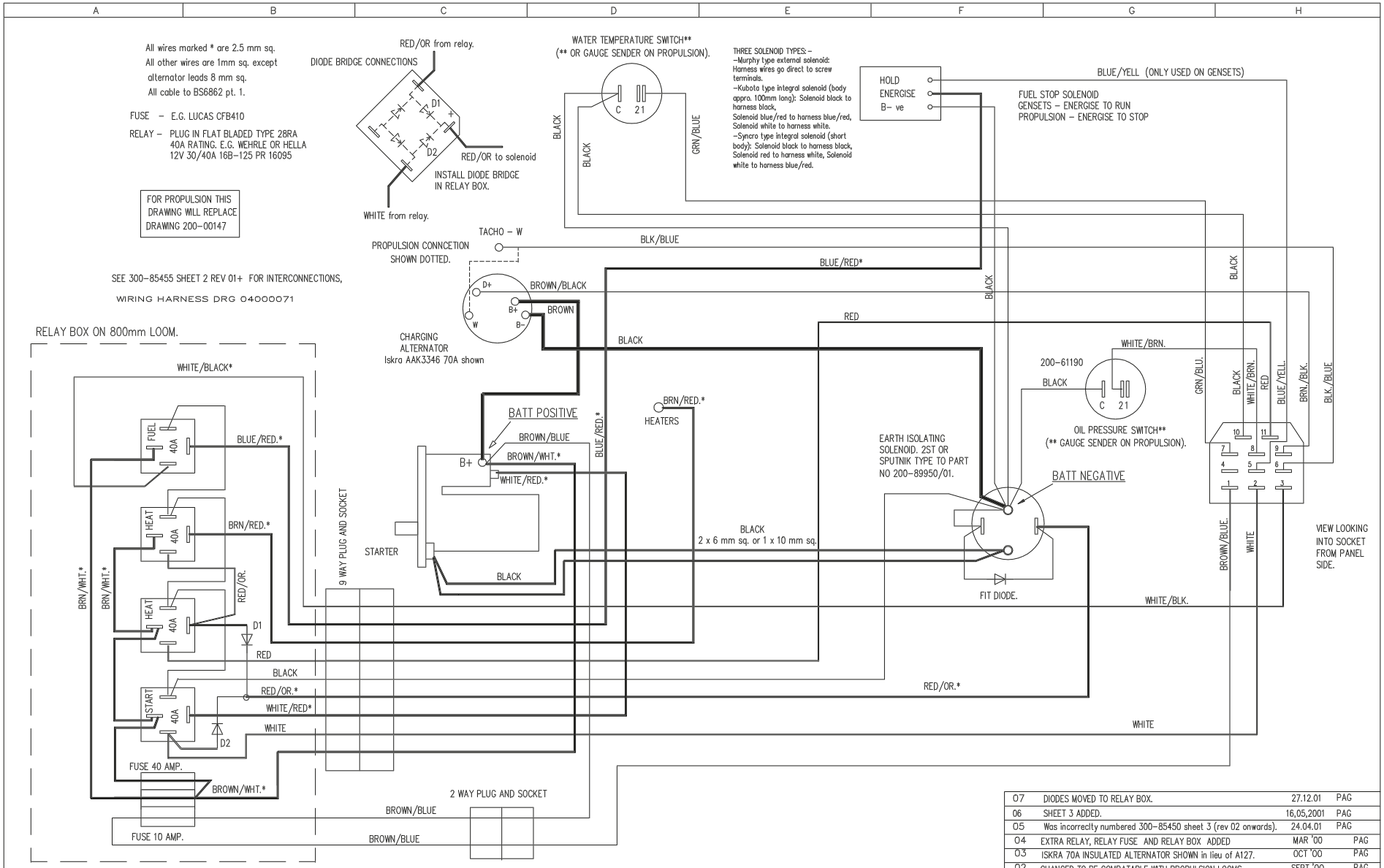
CUSTOMER: CUSTOMER

PROJECT: GROUNDED 2 WIRE ELECTRICS FOR KUBOTA GENSES
STANDARD

SCALE	N/A	A3	
DRAWN	P.A.G.		
ENG.	P.A.G.		
CHECKED			

BETA MARINE

DATE	JULY '95	FILE No.	P/740	DRG No.	300-85450	SHT 1 OF 4	REV	12



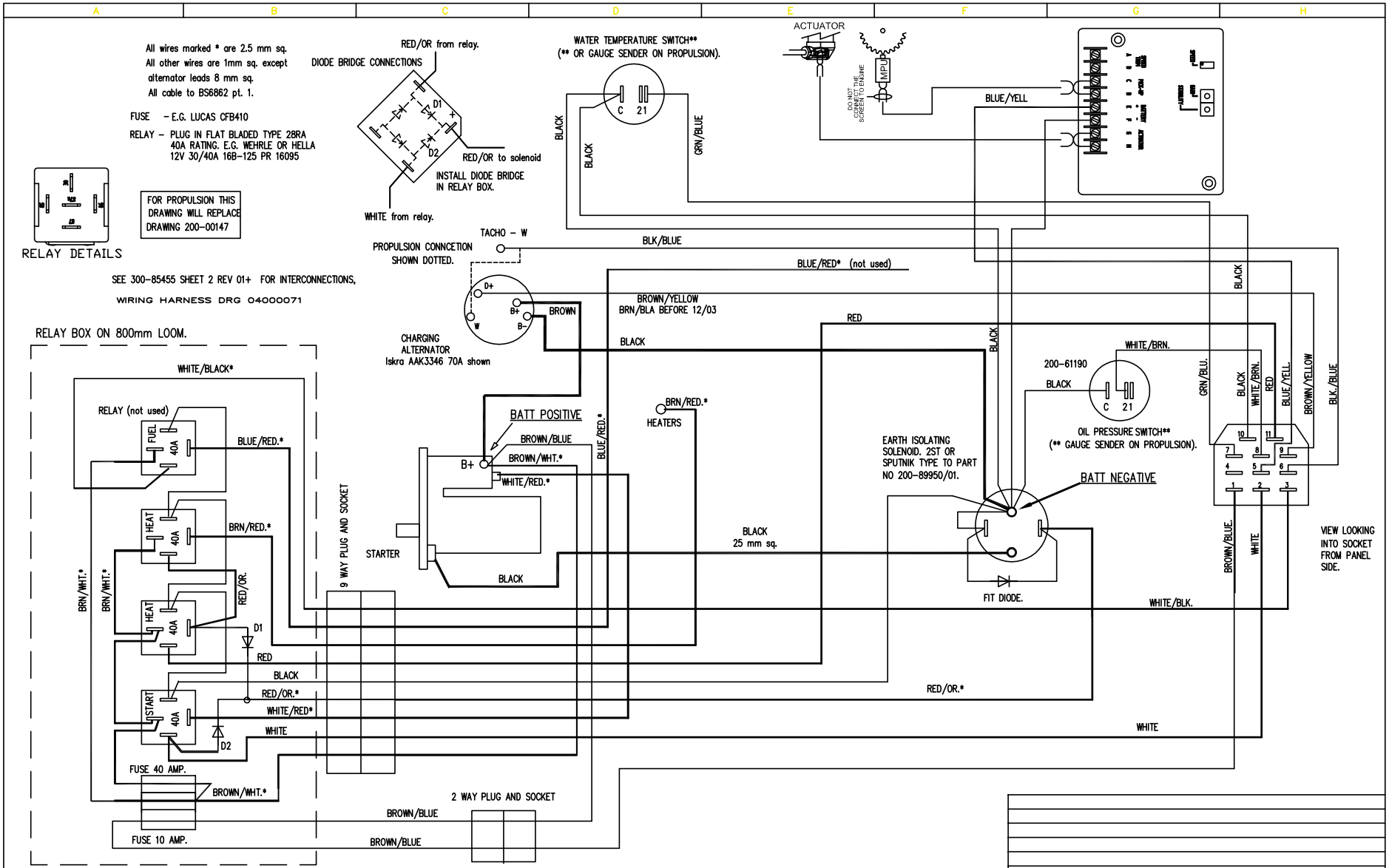
REV	MODIFICATION	DATE	CHECKED
09	FUEL RELAY FED FROM OWN FUSE. WIRE SIZES CONFIRMED.	MAR 02	PAG
08	DIODE BRIDGE USED IN LIEU OF SEPARATE DIODES.	JAN 02	PAG
07	DIODES MOVED TO RELAY BOX.	27.12.01	PAG
06	SHEET 3 ADDED.	16,05,2001	PAG
05	Was incorrecity numbered 300-85450 sheet 3 (rev 02 onwards).	24.04.01	PAG
04	EXTRA RELAY, RELAY FUSE AND RELAY BOX ADDED	MAR '00	PAG
03	ISKRA 70A INSULATED ALTERNATOR SHOWN in lieu of A127.	OCT '00	PAG
02	CHANGED TO BE COMPATABLE WITH PROPULSION LOOMS	SEPT '00	PAG

TITLE
INSULATED RETURN ELECTRICS FOR KUBOTA GENSETS AND PROPULSION ENGINES

SCALE N/A
DRAWN P.A.G.
ENG. P.A.G.
CHECKED

BETA MARINE

DATE	FILE No.	DRG No.	SHEET	REV
JULY '95	P/740	300-85455	1	09

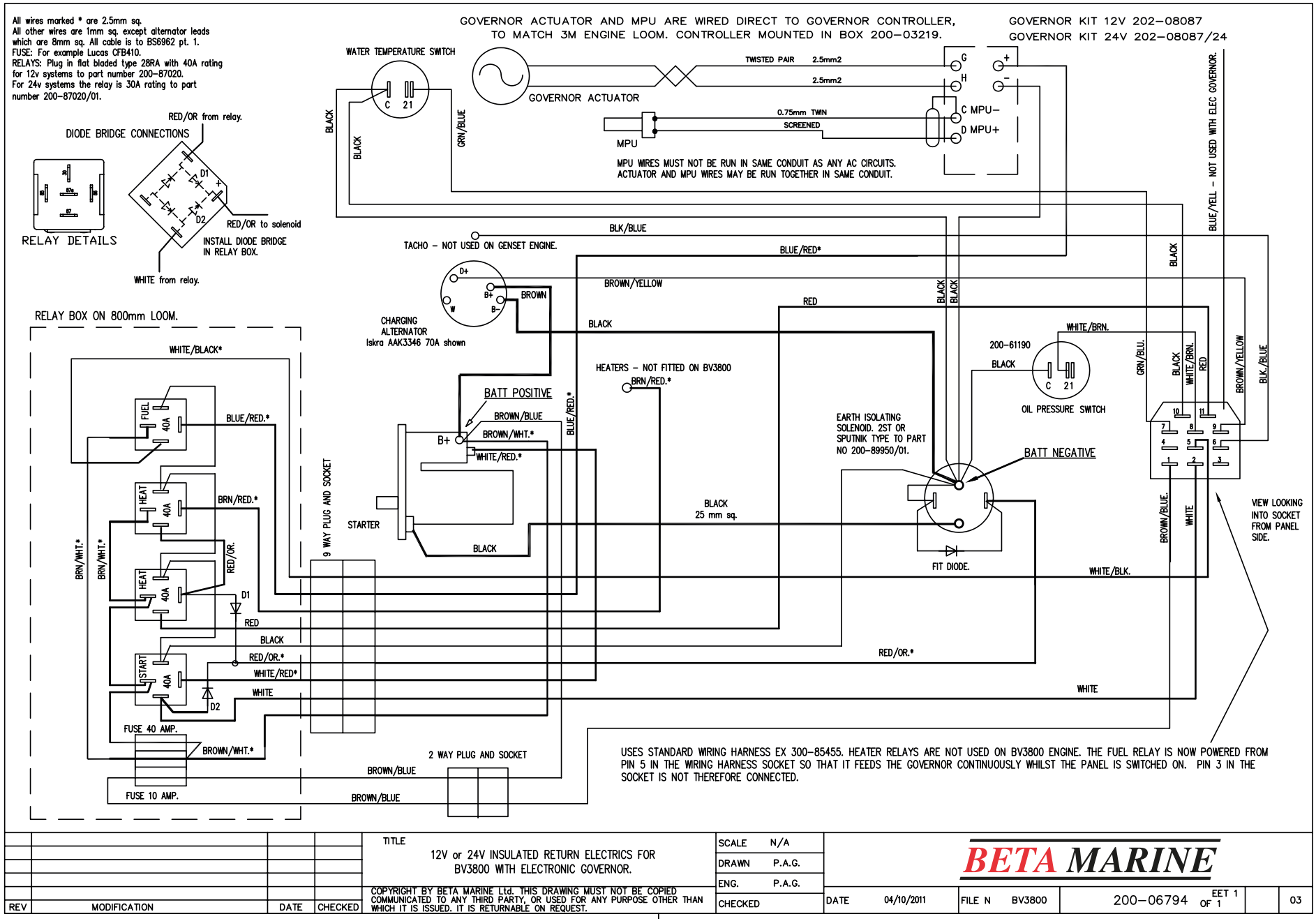


				TITLE: INSULATED RETURN ELECTRICS FOR KUBOTA GENSETS WITH FIXED SPEED GOVENOR
01	+VE WIRE ON GOV	02/10/12	TW	
REV	MODIFICATION	DATE	CHECKED	

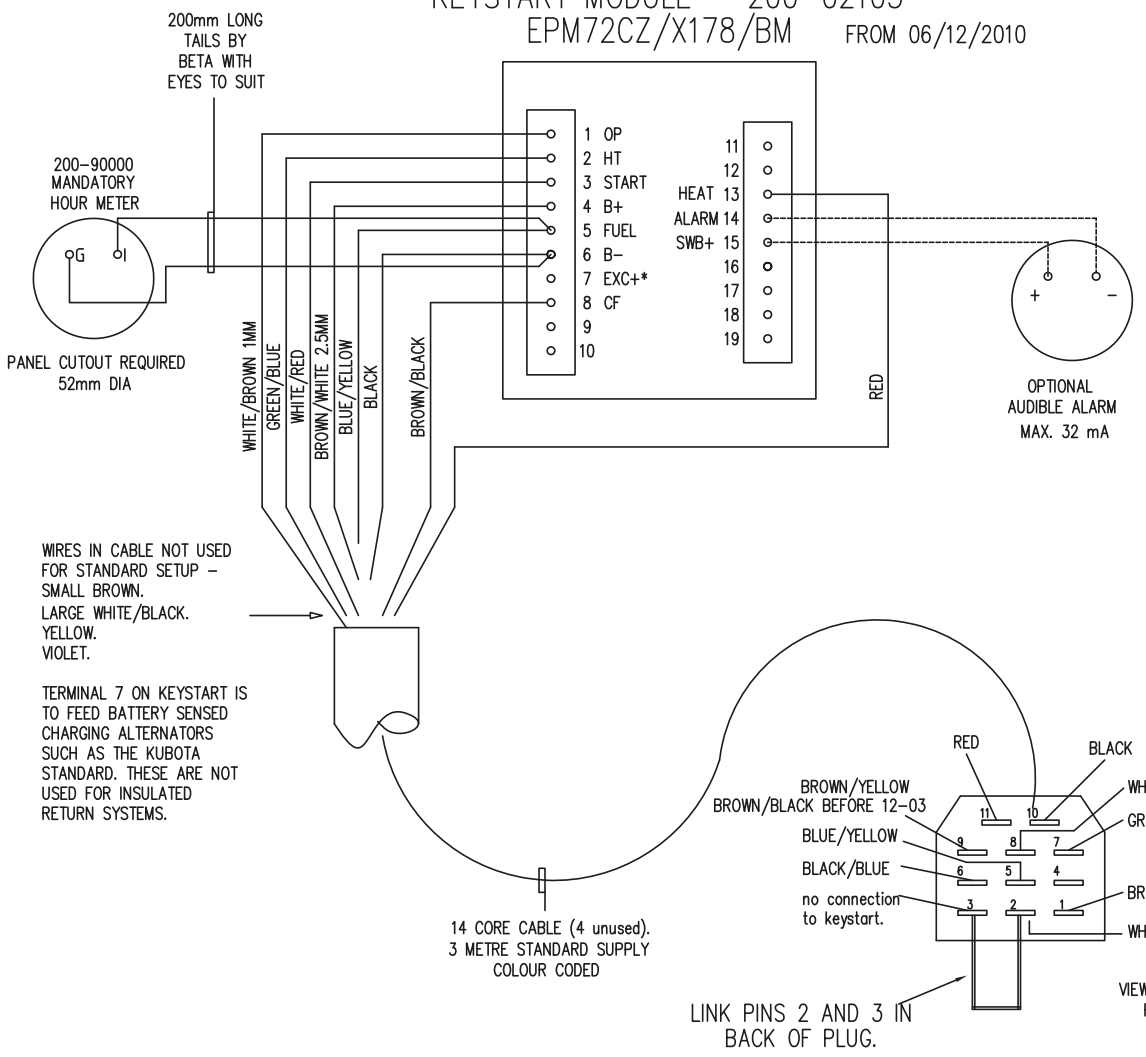
SCALE	N/A
DRAWN	T.W
ENG.	T.W
CHECKED	

BETA MARINE

DATE	FILE No.	DRG No.	REV
27/09/12	P/740	300-09703 SHEET 1	01


All wires marked * are 2.5mm sq.
All other wires are 1mm sq. except alternator leads which are 8mm sq. All cable is to BS6962 pt. 1.
FUSE: For example Lucas CFB410.
RELAYS: Plug in flat bladed type 28RA with 40A rating for 12v systems to part number 200-87020.
For 24v systems the relay is 30A rating to part number 200-87020/01.
DIODE BRIDGE CONNECTIONS
RED/OR from relay.
RED/OR to solenoid
INSTALL DIODE BRIDGE IN RELAY BOX.
WHITE from relay.
RELAY DETAILS
GOVERNOR ACTUATOR AND MPU ARE WIRED DIRECT TO GOVERNOR CONTROLLER, TO MATCH 3M ENGINE LOOM. CONTROLLER MOUNTED IN BOX 200-03219.
GOVERNOR KIT 12V 202-08087
GOVERNOR KIT 24V 202-08087/24
WATER TEMPERATURE SWITCH
GOVERNOR ACTUATOR
TWISTED PAIR 2.5mm2
2.5mm2
0.75mm TWIN SCREENED
MPU
C MPU-
D MPU+
MPU WIRES MUST NOT BE RUN IN SAME CONDUIT AS ANY AC CIRCUITS.
ACTUATOR AND MPU WIRES MAY BE RUN TOGETHER IN SAME CONDUIT.
BLUE/YELL - NOT USED WITH ELEC GOVERNOR.
TACHO - NOT USED ON GENSET ENGINE.
CHARGING ALTERNATOR
Iskra AAK3346 70A shown
RELAY BOX ON 800mm LOOM.
HEATERS - NOT FITTED ON BV3800
BATT POSITIVE
BATT NEGATIVE
STARTER
EARTH ISOLATING SOLENOID. 2ST OR SPUTNIK TYPE TO PART NO 200-89950/01.
FIT DIODE.
200-61190
OIL PRESSURE SWITCH
9 WAY PLUG AND SOCKET
2 WAY PLUG AND SOCKET
FUSE 40 AMP.
FUSE 10 AMP.
VIEW LOOKING INTO SOCKET FROM PANEL SIDE.
USES STANDARD WIRING HARNESS EX 300-85455. HEATER RELAYS ARE NOT USED ON BV3800 ENGINE. THE FUEL RELAY IS NOW POWERED FROM PIN 5 IN THE WIRING HARNESS SOCKET SO THAT IT FEEDS THE GOVERNOR CONTINUOUSLY WHILST THE PANEL IS SWITCHED ON. PIN 3 IN THE SOCKET IS NOT THEREFORE CONNECTED.
TITLE
12V or 24V INSULATED RETURN ELECTRICS FOR BV3800 WITH ELECTRONIC GOVERNOR.
SCALE N/A
DRAWN P.A.G.
ENG. P.A.G.
CHECKED
DATE 04/10/2011
FILE N BV3800
200-06794
SHEET 1 OF 1
03
REV MODIFICATION DATE CHECKED
BETA MARINE
COPYRIGHT BY BETA MARINE Ltd. THIS DRAWING MUST NOT BE COPIED COMMUNICATED TO ANY THIRD PARTY, OR USED FOR ANY PURPOSE OTHER THAN WHICH IT IS ISSUED. IT IS RETURNABLE ON REQUEST.

KEYSTART MODULE – 200–02105
EPM72CZ/X178/BM FROM 06/12/2010



– ENGINE IS PRE–WIRED USING WIRING SHOWN ON 300–85455 SHEET 1, REV 06 +.
– CUT OUT REQUIRED IN MOUNTING PANEL FOR KEYSTART MODULE 66 x 66mm & CLEARANCE DEPTH REQUIRED AT LEAST 160mm.
– TERMINAL 13 ON KEYSTART IS FEEDING OF POWER TO 'HEAT' RELAYS FOR PRE–HEAT AND IS CONTROLLED BY AUTOMATIC TIMER FROM OPERATION OF THE KEYSWITCH. MAXIMUM PRE–HEAT TIME 10 SECONDS.

NOTE:
EPM72CZ/X178/BM SUITS ALL 12V APPLICATIONS WHERE EPM72CZ/X077/BM WAS ORIGINALLY SUPPLIED & IS THE CURRECT REPLACEMENT FOR SPARES.

REV	MODIFICATION	DATE	CHECKED
04	CHANGED CAPRICORN TO 12V ONLY	06/12/10	DM
03	BROWN/YELLOW TO BROWN/YELLOW.	26/04/10	DM
02	Sheet 3 added to show RSM and LPM. Notes corrected to refer to engine wiring 300–85455	16.05.2001	PAG
01	EPM72CZ/X077 DETAILED. TO SUIT ENGINE WIRING 300–85450 rev 03 on.	05.03.01	pag

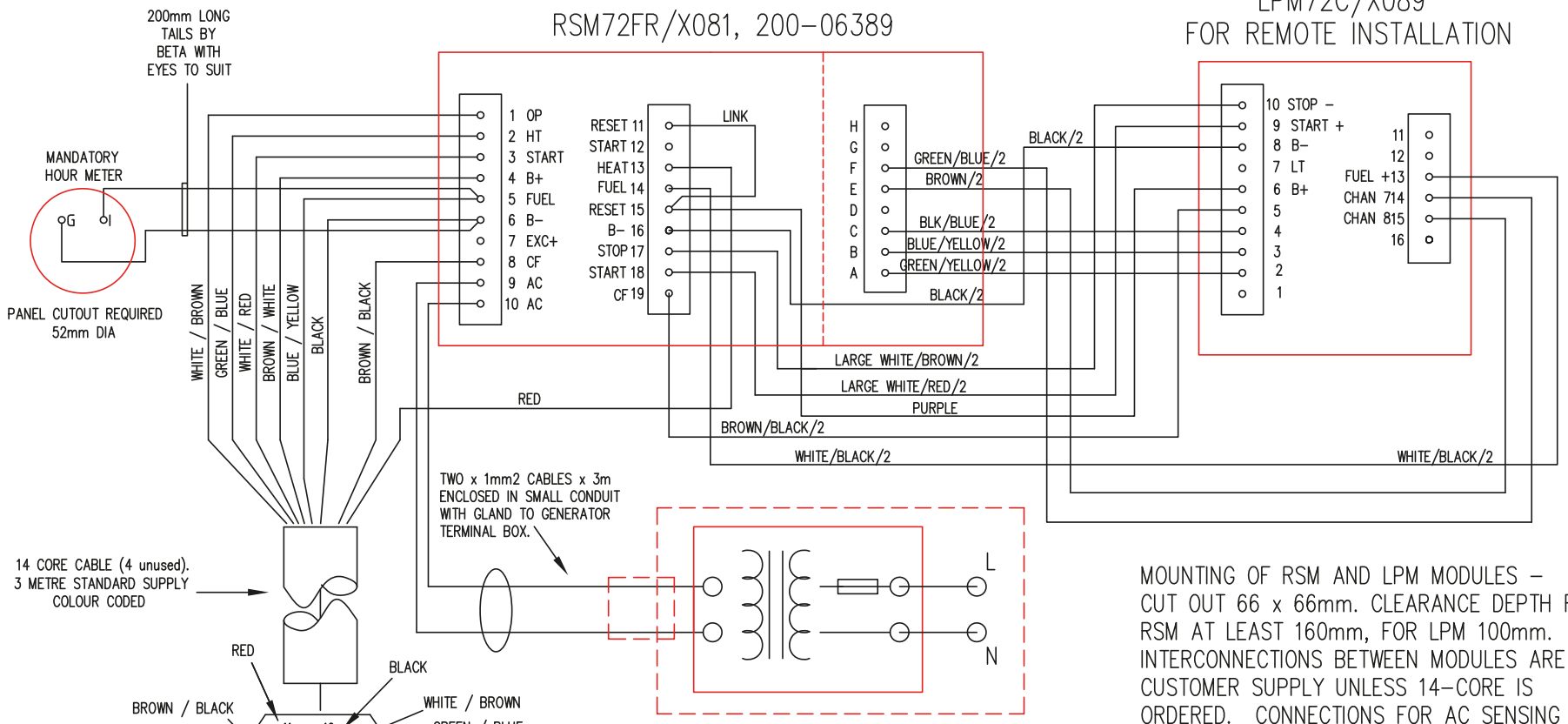
TITLE: KEYSTART CONNECTIONS FOR KUBOTA GENSETS INSULATED RETURN.

SCALE	N/A
DRAWN	P.A.G.
ENG.	P.A.G.
CHECKED	

BETA MARINE

DATE	FILE No.	DRG No.	REV
OCT. 99	P/740	300–85455 SHEET 2	04

RSM MODULE FOR LOCAL INSTALLATION.
RSM72FR/X081, 200-06389



LAMP MODULE - 200-02461
LPM72C/X089
FOR REMOTE INSTALLATION

MOUNTING OF RSM AND LPM MODULES - CUT OUT 66 x 66mm. CLEARANCE DEPTH FOR RSM AT LEAST 160mm, FOR LPM 100mm. INTERCONNECTIONS BETWEEN MODULES ARE CUSTOMER SUPPLY UNLESS 14-CORE IS ORDERED. CONNECTIONS FOR AC SENSING TO RSM ARE PROVIDED BY BETA, STANDARD 3m.

AC MODULE - 200-06388
MOUNTED IN GENERATOR TERMINAL BOX

NOTE: The AC Module is protected by 3.15A Antisurge fuse (20 x 5mm). If the fuse is blown the engine will not start. See label on side of module.

ENGINE WIRING TO 300-85455 sht. 1.

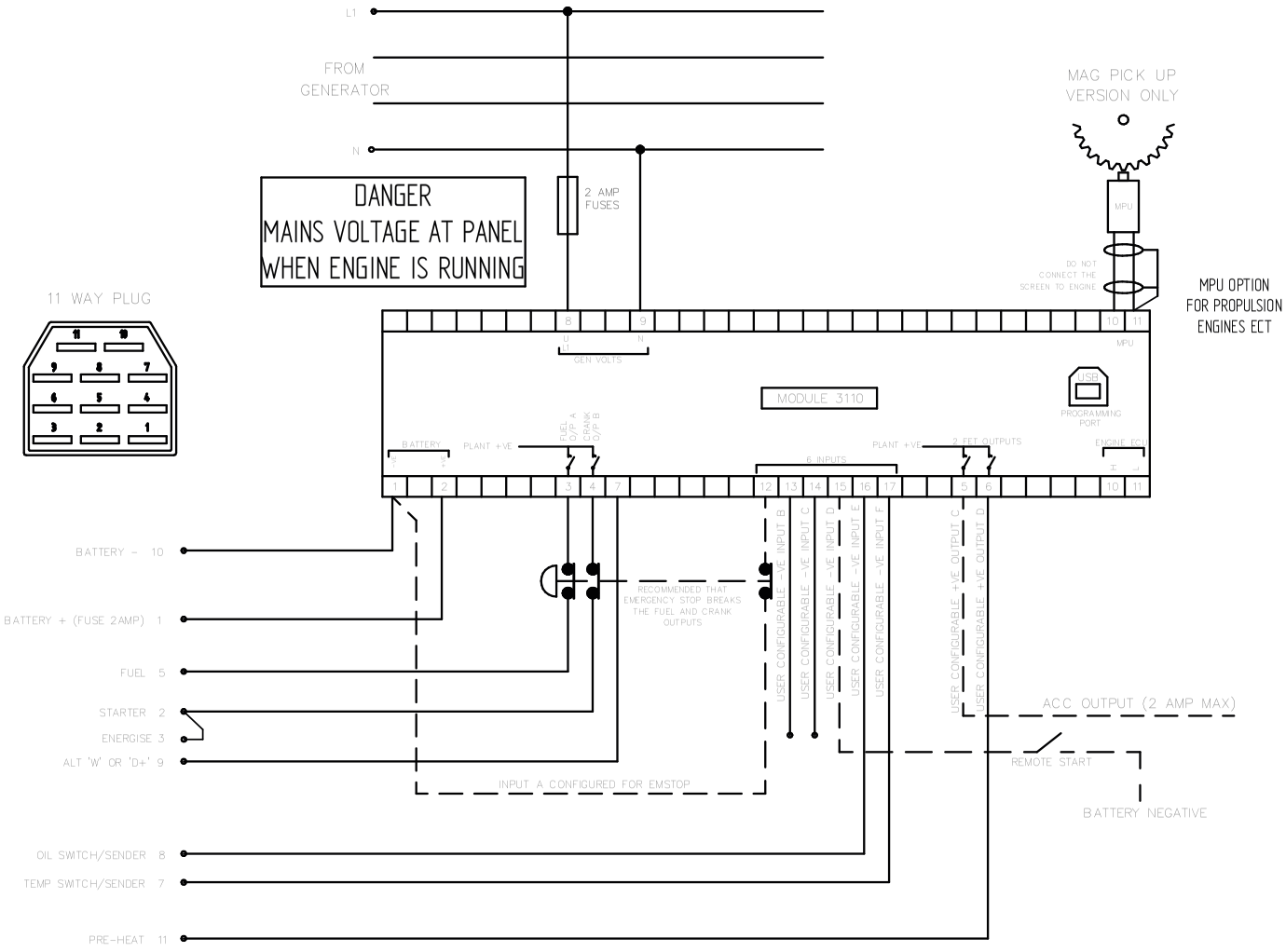
REV	MODIFICATION	DATE	CHECKED
01	AC MODULE FUSE DETAILS ADDED	17.09.18	PAG

TITLE: REMOTE START CONNECTIONS FOR KUBOTA GENSETS, INSULATED.

SCALE N/A | DRAWN P.A.G. | ENG. P.A.G. | CHECKED

BETA MARINE

DATE 26.05.2006 | FILE No. | DRG No. 200-06829 1 OF 1 | REV 01



REV	DESCRIPTION	DATE	APP'D	DRAWN
01	ADDED NOTES	15-05-18	LT	TW

NOTES

TITLE: KUBOTA ENGINE TO DEEPSEA 3110 PANEL INSULATED GENSET ONLY

DIMENSIONS IN MM (INCH) DO NOT SCALE

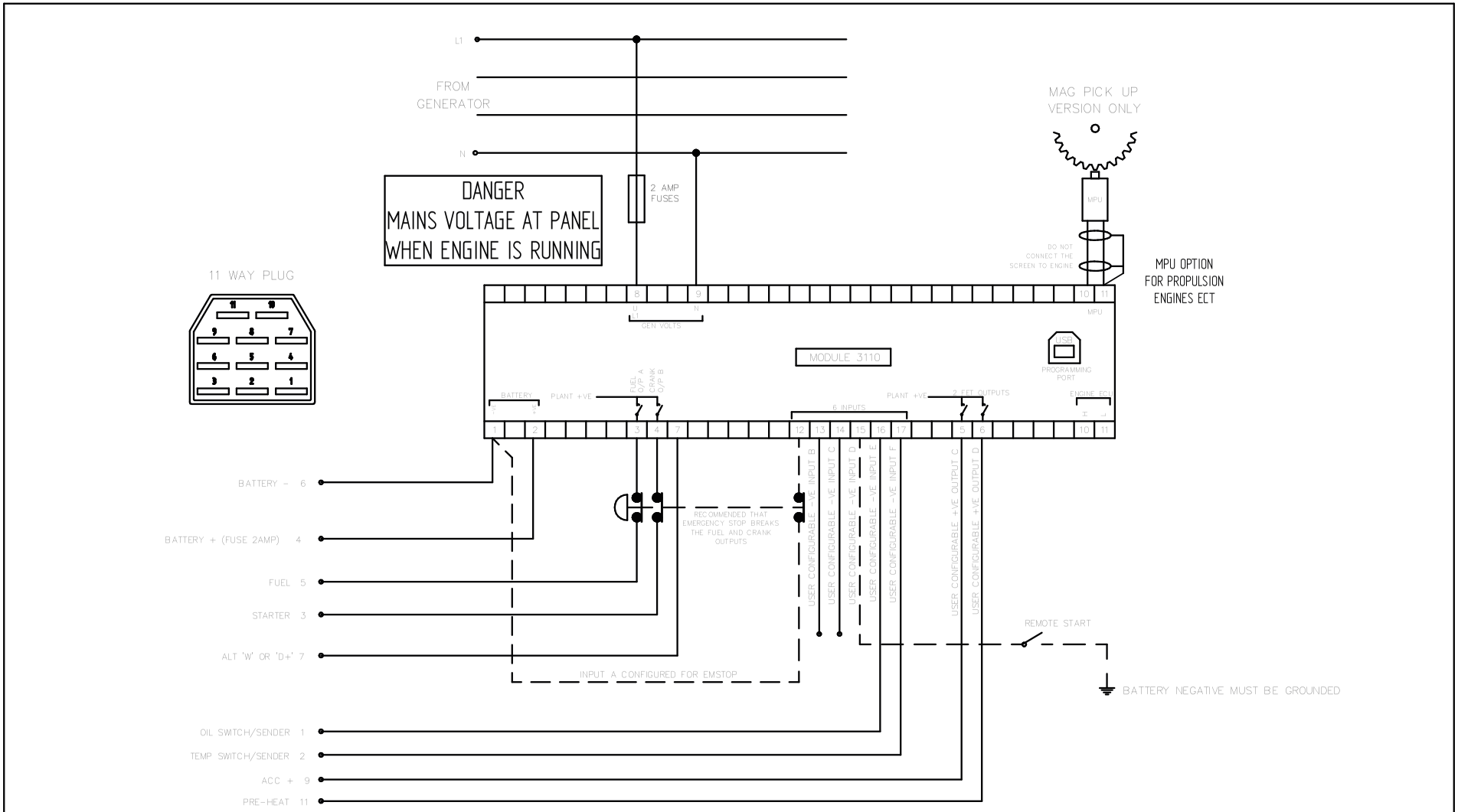
PART FILE NAME: Error: No reference

BETA MARINE

BETA MARINE LTD, DAVY WAY, WATERWELLS, QUEDGELEY, GLOUCESTER. GL2 2AD, UK

TEL: (01452) 723492 FAX: (01452) 729916

DRAWN BY:	SIZE	DWG NO:	REV
timw	A4	200-09050-INS	01
CHECKED BY: LT	SCALE NTS	PAGE 1 of 1	DATE 15/05/2018



REV	DESCRIPTION	DATE	APP'D	DRAWN
01	ADDED MPU	14-11-14	LT	TW
02	ADDED NOTES	15-05-18	LT	TW

NOTES

TITLE:

KUBOTA ENGINE TO DEEPSEA 3110 PANEL

DIMENSIONS IN MM (INCH) DO NOT SCALE

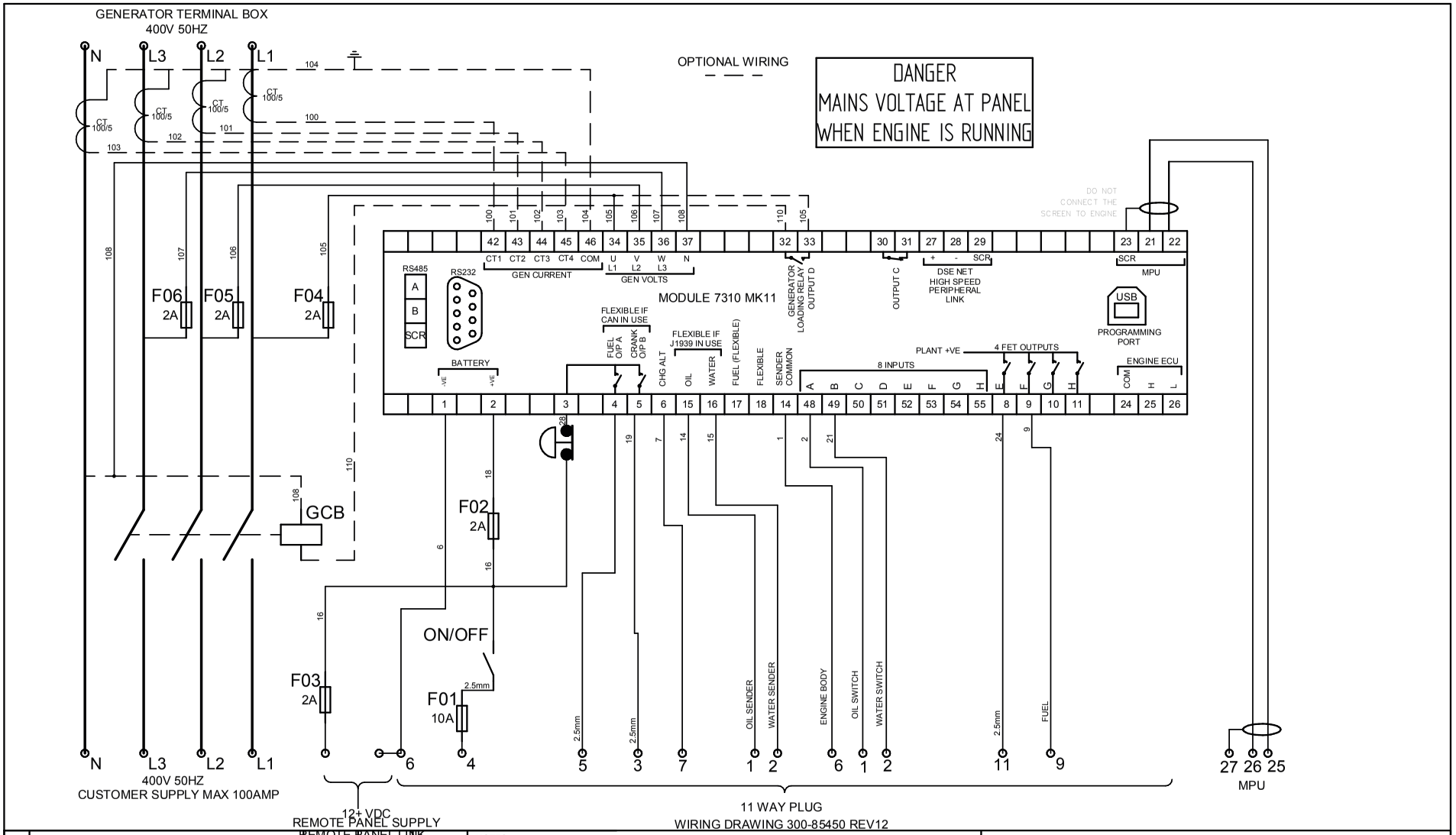
PART FILE NAME: Error: No reference

BETA MARINE

BETA MARINE LTD, DAVY WAY, WATERWELLS, QUEDGELEY, GLOUCESTER. GL2 2AD, UK

TEL: (01452) 723492 FAX: (01452) 729916

DRAWN BY: timw	SIZE A4	DWG NO: 200-09050				REV 02	
CHECKED BY: LT	SCALE NTS	PAGE 1 of 1				DATE 15/05/2018	



REV	DESCRIPTION	DATE	APP'D	DRAWN
01	ADDED NOTES	15-05-18	LT	TW

NOTES NOTES

TITLE: 7310MK11 ON
K GENSET CONTROL PANEL

DIMENSIONS IN MM (INCH)
DO NOT SCALE

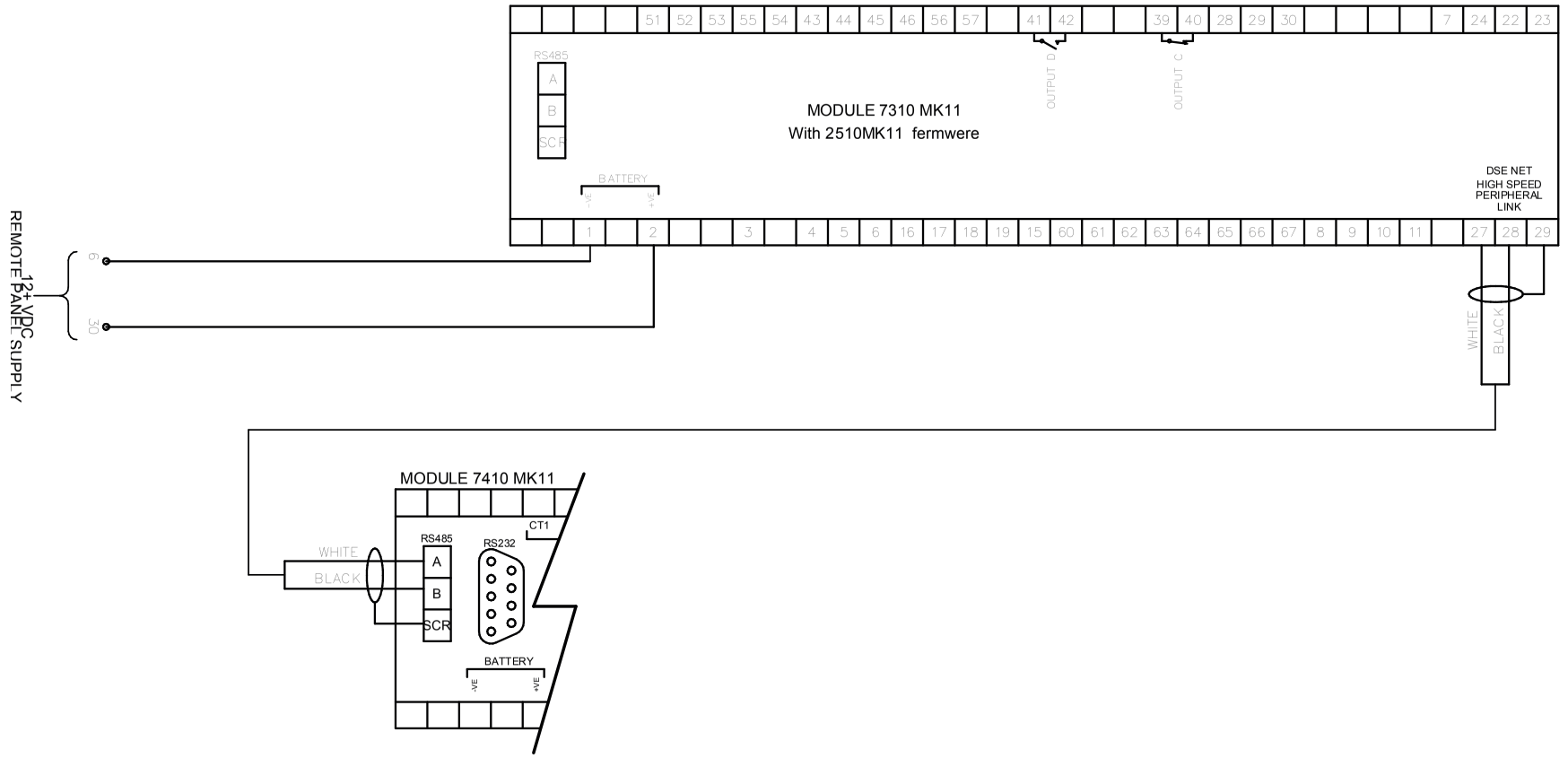
PART FILE NAME: Error: No reference

BETA MARINE

BETA MARINE LTD,
DAVY WAY,
WATERWELLS,
QUEDGELEY,
GLOUCESTER. GL2 2AD, UK

TEL: (01452) 723492 FAX: (01452) 729916

DRAWN BY:	SIZE	DWG NO:	REV
timw	A4	200-11149	01
CHECKED BY:	SCALE NTS	PAGE 1 of 2	DATE 15/05/2018



REV	DESCRIPTION	DATE	APP'D	DRAWN
01	ADDED NOTES	15-05-18	LT	TW

NOTES

NOTES

REMOTE MODULE SUPPLIED LOOSE

TITLE:

7310MK11 ON
K GENSET CONTROL PANEL

DIMENSIONS IN MM (INCH)
DO NOT SCALE

PART FILE NAME: Error: No reference

BETA MARINE
TEL: (01452) 723492 FAX: (01452) 729916
BETA MARINE LTD,
DAVY WAY,
WATERWELLS,
QUEDGELEY,
GLOUCESTER. GL2 2AD, UK

DRAWN BY: timw

CHECKED BY:

SIZE A4

DWG NO: 200-11149

REV 01

SCALE NTS

PAGE 2 of 2

DATE 15/05/2018

Section 6: Emissions

BETA MARINE

QA F 008E
DECLARATION OF CONFORMITY
REVISION 01
DATE AUGUST 2018

Beta Marine Limited
Davy Way
Waterwells
Quedgeley
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Tel: +44 (0)1452 723492
Fax: +44 (0)1452 883742
Email: sales@betamarine.co.uk
www.betamarine.co.uk

EU DECLARATION OF CONFORMITY

The Beta range of marine generator set engines BetaSet/Gen 7 through BetaSet/Gen 49 and BetaSet/Gen 4/2 through BetaSet/Gen 25/2.

Manufactured by Beta Marine Limited at the address given above.

This declaration of conformity is issued under the sole responsibility of the manufacturer.

The object of this declaration is to confirm compliance of the engine in accordance with the exhaust emission requirements of directive 97/68/EC in conformity with the relevant Union harmonised legislation.

Standards used include in part as applicable, ISO 3046 and engines are preapproved in accordance with Stage IIIA of the Directive except where mentioned.

For detailed list please contact Beta Marine Ltd or refer to our website.

The person empowered to sign on behalf of Beta Marine Limited is Mr J. A. Growcoot who is the Chief Executive Officer of the company.

Individual certificates applicable to any particular engine serial number will be issued on request in any requested EU approved European language applicable to the country in which the installation is made.

Signed for and on behalf of Beta Marine Limited.

Dated: 1st August 2018.

Important!

Beta Marine Ltd operates a policy of continuous improvement and reserves the right to change prices & specification without prior notification. Information given is subject to our current conditions of tender & sale.

All products with moving parts can be dangerous if used improperly;

Always Read Instructions For Use, Carefully.

Product and performance can vary from market to market, ask your dealer or Beta Marine about available product, performance and accessories in your market.

All technical data within this manual was correct at the time of printing, but such data is subject to change due to ongoing product development.

To view and download pdf files of the latest relevant documents visit: **www.betamarine.co.uk**

Hazardous Materials

Used engine oils - may contain hazardous components which may have the potential to cause skin cancer. In the case of contact, immediately rinse skin with plenty of water for several minutes and then wash contact area with soap and water. Keep out of reach of children.

The rules & regulations for the disposal of waste oil and or antifreeze solutions in the UK varies by location and whether you are a business or a private individual.

To find your nearest disposal bank or learn more visit: **www.oilcare.org.uk**

For the safe and legal way to dispose of hazardous materials outside the UK, carefully check and comply with the legal requirements in your country.

Notes...

Notes...

Section 7: Consumable Service Parts

4-Pole Generating Set Model	BetaSet/Gen 7 ☐
Heat Exchanger Fuel Filter	211-60210 (SET) or 211-02817 (GEN)
Keel Cooled Fuel Filter	211-60210 (SET) or 211-02817 (GEN)
Lube Oil Filter	211-60390
Air Filter	211-08132
Heat Exchanger Sacrificial Anode	209-61840
Heat Exchanger O-Rings	2 x 212-07273
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Belt Drive Pump	207-09041-KIT
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Gear Drive Pump	✗
45 Amp 12v Grounded Earth Starter Battery Alternator V Drive Belt	214-00292
70 Amp 12v Insulated Return Earth Starter Battery Alternator V Drive Belt	214-63090/Q
55 Amp 24v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
Heat Exchanger Seawater Pump V Drive Belt	**PNA***

4-Pole Generating Set Model	BetaSet/Gen 21 ☐
Heat Exchanger Fuel Filter	211-60210
Keel Cooled Fuel Filter	211-60210
Lube Oil Filter	211-70510/02
Air Filter	211-09179
Heat Exchanger Sacrificial Anode	209-61840
Heat Exchanger O-Rings	2 x 212-07273
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Belt Drive Pump	207-02132-KIT
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Gear Drive Pump	207-09042-KIT
45 Amp 12v Grounded Earth Starter Battery Alternator V Drive Belt	600-01361
70 Amp 12v Insulated Return Earth Starter Battery Alternator V Drive Belt	214-96830
55 Amp 24v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
Heat Exchanger Seawater Pump V Drive Belt	**PNA***

4-Pole Generating Set Model	BetaSet/Gen 40T IIIA ☐
Heat Exchanger Fuel Filter	**PNA***
Keel Cooled Fuel Filter	**PNA***
Lube Oil Filter	**PNA***
Air Filter	**PNA***
Heat Exchanger Sacrificial Anode	209-61840
Heat Exchanger O-Rings	**PNA***
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Belt Drive Pump	**PNA***
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Gear Drive Pump	**PNA***
45 Amp 12v Grounded Earth Starter Battery Alternator V Drive Belt	**PNA***
70 Amp 12v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
55 Amp 24v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
Heat Exchanger Seawater Pump V Drive Belt	**PNA***

BetaSet/Gen 10 ☐	BetaSet/Gen 12 ☐	BetaSet/Gen 14 ☐
211-60210 (SET) or 211-02817 (GEN)	211-60210 (SET) or 211-02817 (GEN)	211-60210
211-60210 (SET) or 211-02817 (GEN)	211-60210 (SET) or 211-02817 (GEN)	211-60210
211-60390	211-60390	211-70510/02
211-08132	211-08132	211-09179
209-61840	209-61840	209-61840
2 x 212-07273	2 x 212-07273	2 x 209-80110
207-09041-KIT	207-09041-KIT	207-02132-KIT
✗	✗	207-09042-KIT
214-00292	214-00292	600-01361
214-63090/Q	214-63090/Q	214-96830
PNA*	**PNA***	**PNA***
PNA*	**PNA***	**PNA***

BetaSet/Gen 26 ☐	BetaSet/Gen 33 ☐	BetaSet/Gen 40 ☐
211-60210	211-60210	211-02817
211-60210	211-60210	211-02817
211-70510/02	211-70510/02	211-70510/02
211-03819	211-03819	211-03819
209-61840	209-61840	209-61840
2 x 209-00814	2 x 209-00814	2 x 209-00814
207-02132-KIT	207-02132-KIT	207-10709
✗	✗	✗
✗	✗	✗
214-99226	214-99226	214-99226
PNA*	**PNA***	**PNA***
PNA*	**PNA***	**PNA***

BetaSet/Gen 49 ☐	BetaSet/Gen 49T IIIA ☐
211-02817	**PNA***
211-02817	**PNA***
211-70510/02	**PNA***
211-03819	**PNA***
209-61840	209-61840
2 x 209-00814	**PNA***
207-10709	**PNA***
✗	**PNA***
✗	**PNA***
214-99226	**PNA***
PNA*	**PNA***
PNA*	**PNA***

✗ - Not Applicable.

***PNA** - Part No On Application Due To Variance, K WOC Number or Engine Serial No Required. Once Known Please Populate PN In Available Space For Future Reference.

Section 7: Consumable Service Parts

2-Pole Generating Set Model	BetaSet/Gen 4/2 ☐
Heat Exchanger Fuel Filter	211-60210
Keel Cooled Fuel Filter	211-60210
Lube Oil Filter	211-63760
Air Filter	211-08132
Heat Exchanger Sacrificial Anode	209-61840
Heat Exchanger O-Rings	2 x 212-07273
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Belt Drive Pump	207-09041-KIT
45 Amp 12v Grounded Earth Starter Battery Alternator V Drive Belt	214-00292
70 Amp 12v Insulated Return Earth Starter Battery Alternator V Drive Belt	214-63090/Q
55 Amp 24v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
Heat Exchanger Seawater Pump V Drive Belt	**PNA***

2-Pole Generating Set Model	BetaSet/Gen 25/2 ☐
Heat Exchanger Fuel Filter	211-60210 (SET) or 211-02817 (GEN)
Keel Cooled Fuel Filter	211-60210 (SET) or 211-02817 (GEN)
Lube Oil Filter	211-60390
Air Filter	211-08132
Heat Exchanger Sacrificial Anode	209-31840
Heat Exchanger O-Rings	2 x 212-07273
Heat Exchanger Seawater Pump Impellor Kit - Inc. O-Ring - Belt Drive Pump	207-09041-KIT
45 Amp 12v Grounded Earth Starter Battery Alternator V Drive Belt	214-00292
70 Amp 12v Insulated Return Earth Starter Battery Alternator V Drive Belt	214-63090/Q
55 Amp 24v Insulated Return Earth Starter Battery Alternator V Drive Belt	**PNA***
Heat Exchanger Seawater Pump V Drive Belt	**PNA***

BetaSet/Gen 6/2 ☐	BetaSet/Gen 11/2 ☐	BetaSet/Gen 22/2 ☐
211-60210	211-60210	211-60210 (SET) or 211-02817 (GEN)
211-60210	211-60210	211-60210 (SET) or 211-02817 (GEN)
211-63760	211-63760	211-60390
211-08132	211-08132	211-08132
209-61840	209-61840	209-31840
2 x 212-07273	2 x 212-07273	2 x 212-07273
207-09041-KIT	207-09041-KIT	207-09041-KIT
214-00292	214-00292	214-00292
214-63090/Q	214-63090/Q	214-63090/Q
PNA*	**PNA***	**PNA***
PNA*	**PNA***	**PNA***

✗ - Not Applicable.

***PNA** - Part No On Application Due To Variance, K WOC Number or Engine Serial No Required. Once Known Please Populate PN In Available Space For Future Reference.

Section 8: Service Record

	Service	Date	Responsible	
1	Commissioned			
2	First 25 hours			
3	First 50 hours			
4	Every 150 hours with shallow sump			
5	Every Year/Every 250 hours if sooner			
6				
7				
8				
9	Every Year/Every 750 hours if sooner			
10				
11				
12				
13				
14				
15				
16				

	Service	Date	Responsible	
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				

	Service	Date	Responsible	
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				

	Service	Date	Responsible	
49				
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BETA MARINE

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Ref: OM 221-20033 REV 13 - 0220