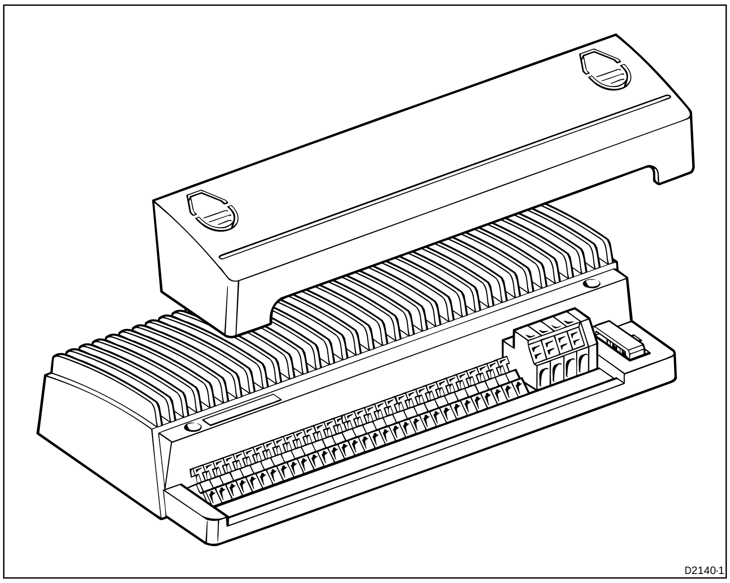


Service Procedures for:

Q068, Type 300 12V Autopilot Course Computer (Z166 Core Pack)

Q069, Type 300 24V Autopilot Course Computer (Z167 Core Pack)

Q067, Type 100 12V Autopilot Course Computer (Z168 Core Pack)

CE MARKING OF EQUIPMENT/REPLACEMENT PARTS

WARNING

If the Autohelm equipment under repair, test, calibration, installation or setting to work carries the European CE mark, only parts and components supplied or approved for such use by Autohelm should be used in order to maintain compliance with the relevant CE requirements.

Incorporation, use or attachment, by any means, of parts or components not supplied for or not approved for such use by Autohelm or, if supplied or approved for use by Autohelm, not properly fitted in accordance with instructions published, provided or recommended by Autohelm, may cause the equipment to malfunction and, in particular, to become unsafe or to no longer meet the relevant CE requirements. In these circumstances, Raytheon Marine Europe Ltd excludes liability to the fullest extent permissible in law for any loss or damage including any liability for its contribution to such loss or damage by its negligent acts or omissions .

Contents

Illustrations

1. Description

This section of the Maintenance Manual covers all three variants of the Course Computer:

Q068, Type 300 12V Autopilot Course Computer (Z166 Core Pack)

Q069, Type 300 24V Autopilot Course Computer (Z167 Core Pack)

Q067, Type 100 12V Autopilot Course Computer (Z168 Core Pack)

1.1 General

The Type 100/300 Course Computer is SeaTalk compatible and consists of a case containing a PCB which carries a microcontroller, drive unit, power amplifier, protection relays and a connector block for all inputs and outputs.

Type 100 is used with Type 1 and Type CR 12V drives. Type 300 is used with Type 2 and Type 3 12V or 24V drives.

1.2 Variants

Functions of all three variants are identical. The difference between Type 300 24V and Type 300 12V is the input voltage and motor output voltage. Between 12V variations, Type 100 and Type 300, the difference is the power handling capabilities of the motor output.

All other inputs and outputs (SeaTalk, compass etc.) produce or need the same signal levels whatever the variant.

Mechanically, all three variants are identical in that the computer consists of a case with top and bottom parts containing a PCB.

2. Operation

There are no operations needed to set up the computer for testing.

3. Disassembly

Refer to Figure 1, Exploded View.

1. Remove the terminal cover (1)
2. Unscrew and remove the four M3 screws (12) on the lower case (11). Remove the lower case
3. To remove the PCB (8), unscrew and remove the five M2 screws (9). Unscrew by two or three turns the location comb screws (5). (Note that computers from serial number 0360001 use machine screws and require a 2.5mm hexagon key). Access to these screws is gained through two holes in the PCB, one of which is shown in Figure 2, behind and to the left (as viewed) of the line of FETs (13). Do not remove the screws at this stage. Lift the PCB out of the upper case (2)
4. Remove the location comb (4) by unscrewing and removing the two screws (5)
5. If the insulation strip (3) is damaged, out of position or a new location comb is to be fitted (see Assembly Instruction 3), carefully peel off the old strip and clean any remaining adhesive and heat transfer compound off the case
6. The insulating strip (10) fits over the legs of the connectors and can be removed if necessary.

4. Assembly

Refer to Figure 1, Exploded View and Figure 2, Location Comb Assembly Detail.

1. Apply heat sink compound (14) to the area of the case where the insulation strip (3) fits. Apply double sided sticky tape to the case and attach the insulation strip as shown in Figure 2 detail 1. Bend the strip over the edge and apply a second layer of heat transfer compound (Figure 2 detail 2)
2. Fit the location comb (4) into the upper case (2) with the two M2 screws (5). Do not tighten the screws at this stage. (Note: Check that the location comb has the new shape as shown in Figure 2. If not, use Autohelm Course Computer Modification Kit Q098 to replace the old shape comb with a new shape comb)
3. To replace the PCB (8) in the upper case (2), hold the lower case so that the location comb falls away from the insulation strip (3). Ensure that the lip of the location comb does not come out of the flange in the case.
4. Position the PCB next to the upper case (2) and bring the two together so that the FETs (13) are between the location comb (4) and the insulation strip (3) (Figure 2 detail 3) . Ensure that the lip of the location comb

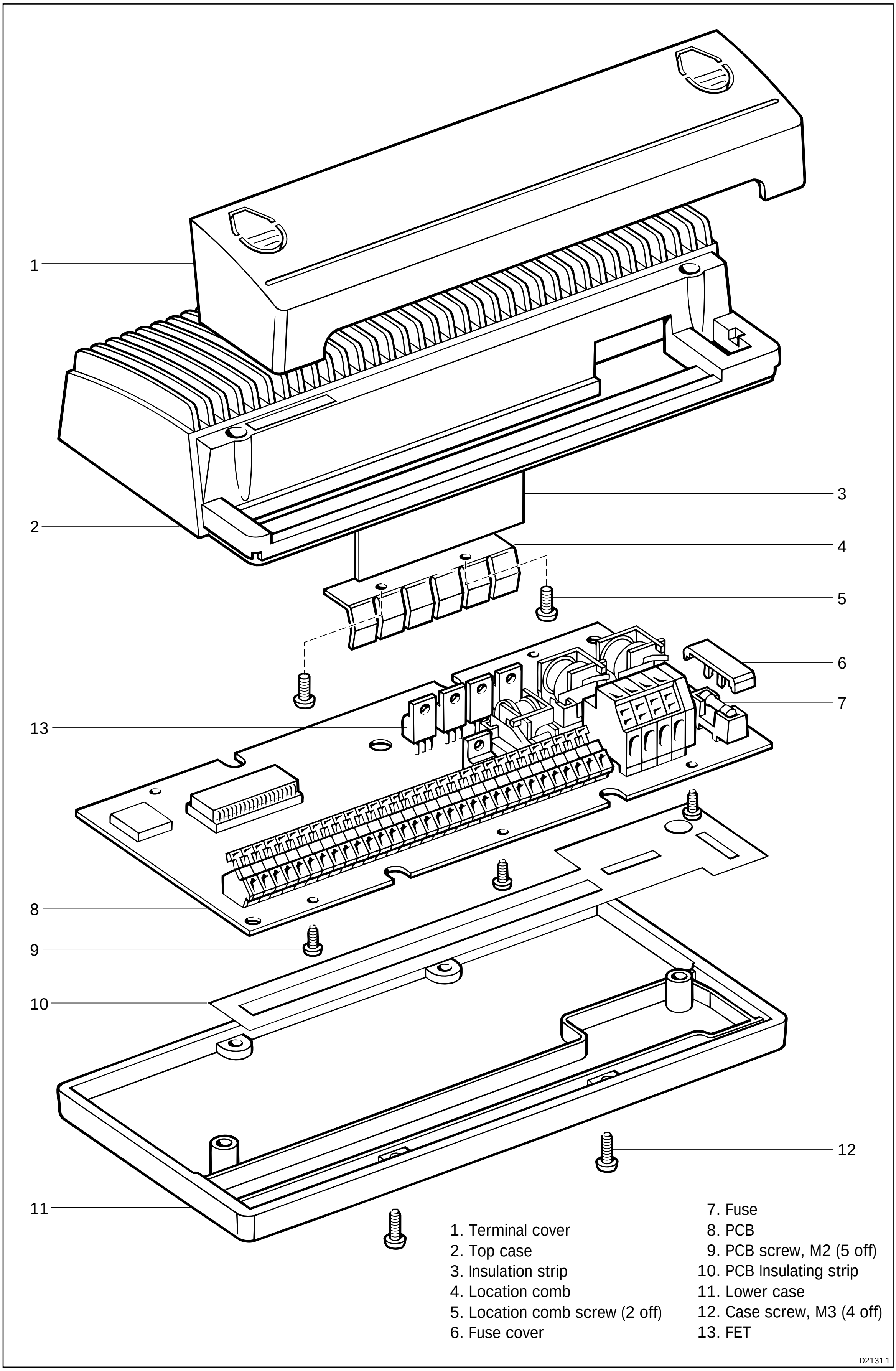


Figure 1 Exploded View

remains in the flange in the case

5. Insert and screw in the five M2 screws (9) to secure the PCB. Tighten the location comb screws through the holes in the PCB
6. Press the insulating strip (10) over the legs of the connectors on the PCB
7. Position the lower case (11) over the upper case, insert and tighten the four M3 screws (12)
8. Replace the terminal cover (1).

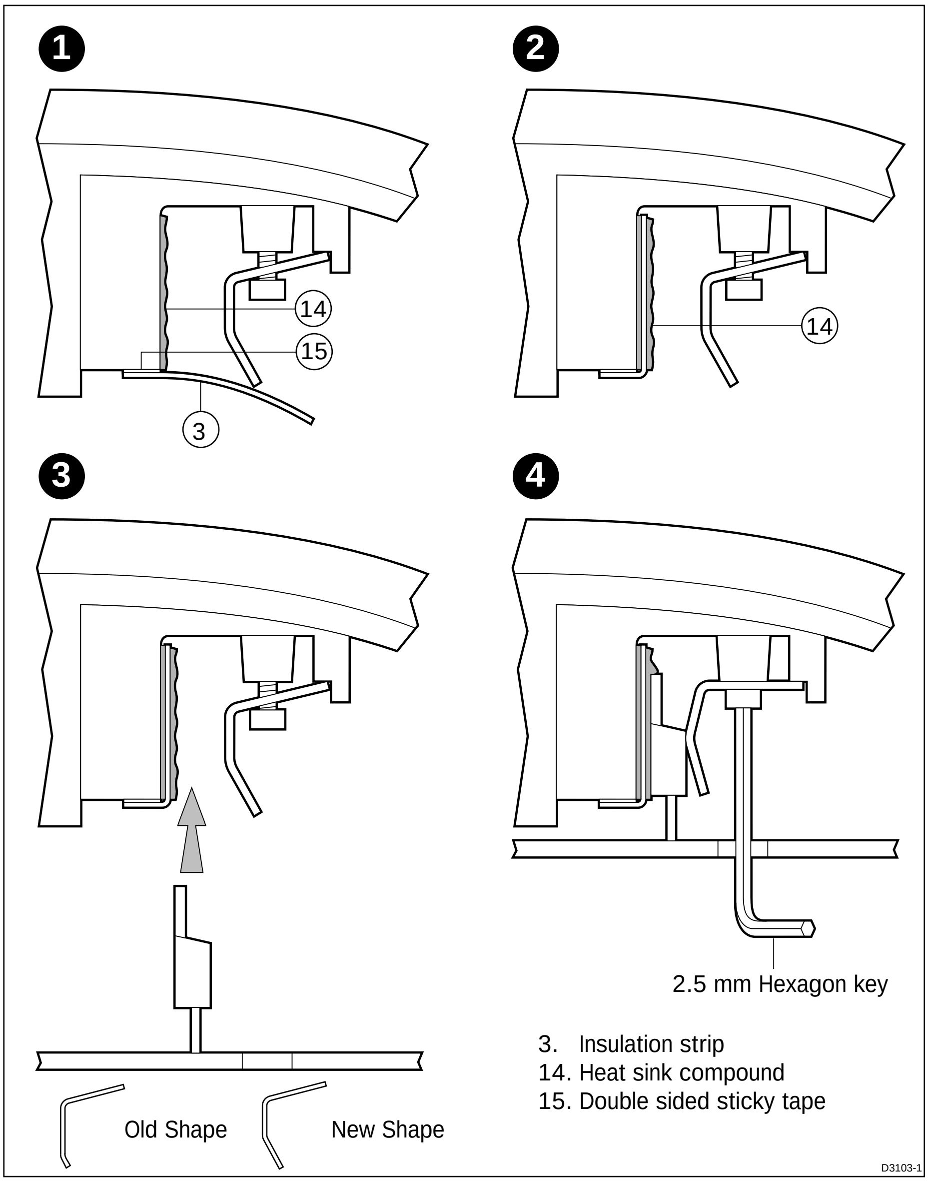


Figure 2 Location Comb Assembly Detail

5. Functional Test

5.1 Pre - checked Equipment Required

1. SeaTalk Control Unit (Z082)
2. Fluxgate Compass (Z130 or Z105)
3. ST50 Wind Display in Boat Show mode (Z094)
4. Rudder Reference Transducer (Z131)
5. Joystick (Z147)
6. Multimeter
7. Motor for Z166, Z168 (12V) (N002)
8. Motor for Z167 (24V) (N003)
9. Power Supply (minimum rating 20A)
10. SeaTalk Cable (D124)
11. Clutch Coil (N007)

5.2 Functional Test Procedure

1. Connect all units to the course computer in accordance with the connection diagram (Figure 3)
2. Position and secure the rudder reference arm diametrically opposite the cable gland of the transducer
3. Connect 12V (Z166, Z168) or 24V (Z167) to the test rig. Do not switch on
4. Start tests shown by the Functional Test Flowchart. After a PCB change, which effectively produces a new instrument, the tests restart each time.

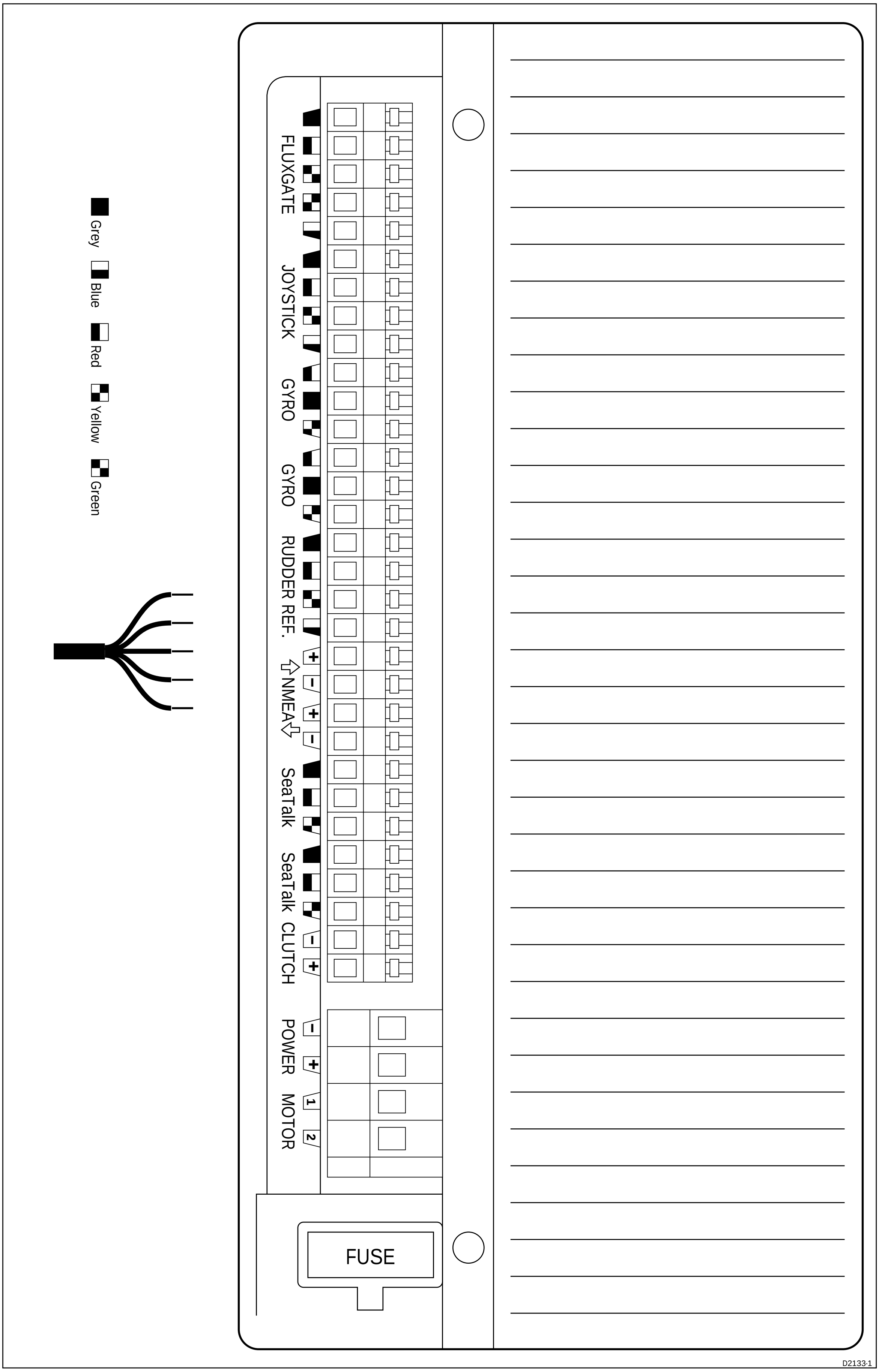
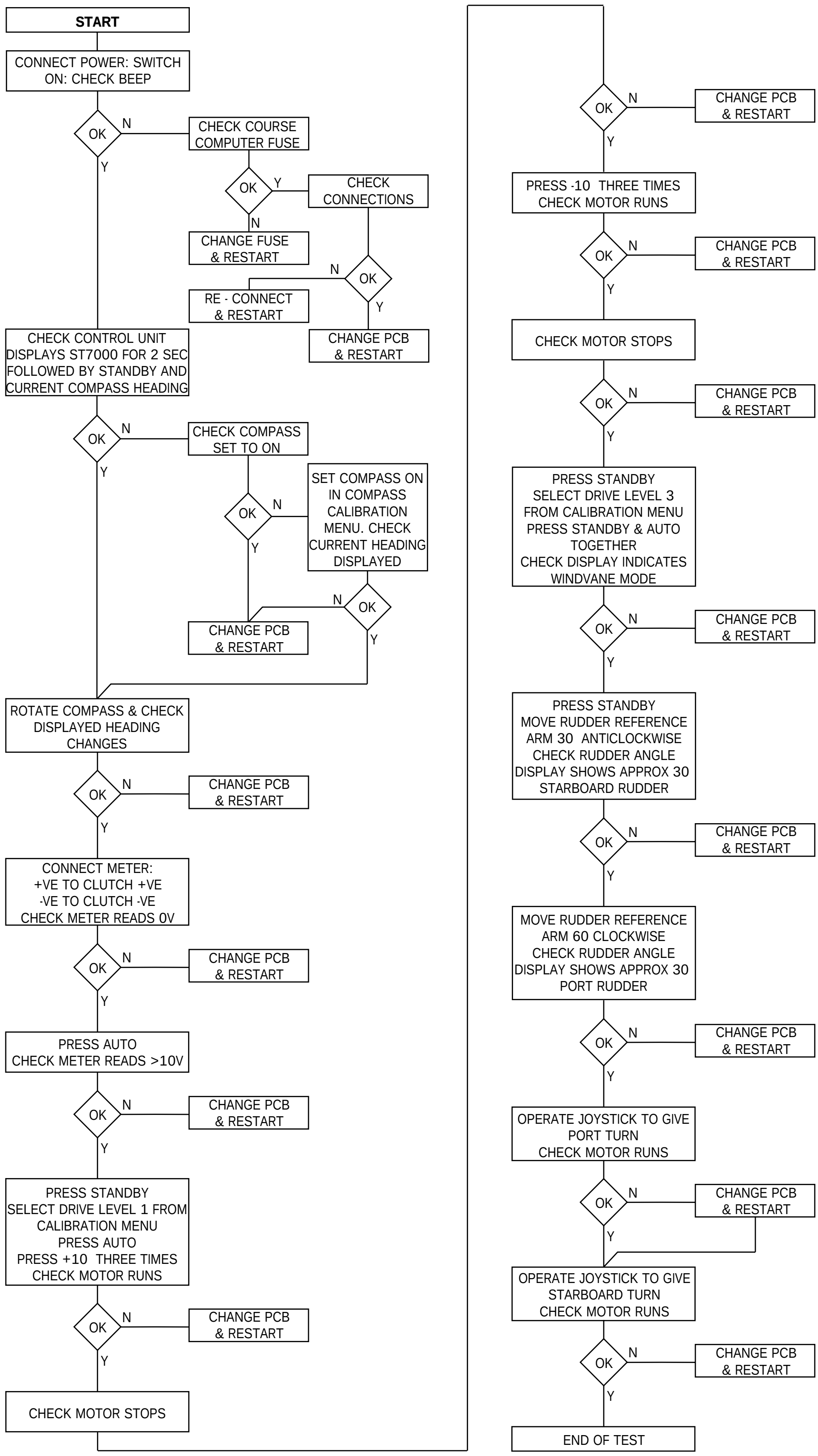


Figure 3 Connections to Terminals

5.3 Functional Test Flowchart



6. Product History

6.1 Q067, Type 100

Change	Serial Number	Comments
Production start	330001	
New assembly method	360001	
Modified heat sink clamp	530051	
Low battery board mod	440127	
Final test to incorporate cal lock check	950001	

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6.2 Q068, Type 300 (12V)

Change	Serial Number	Comments
Production start	330001	
New assembly method	360001	
Modified heat sink clamp	530041	
Issue C PCB	1030001	
Screwlock intro on compass weight nut	1130001	
Low battery board mod	440028	
Final test to incorporate cal lock check	950001	

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6.3 Q069, Type 300 (24V)

Change	Serial Number	Comments
Production start	330001	
New assembly method	360001	
Modified heat sink clamp	530051	
Low battery board mod	540001	
Final test to incorporate cal lock check	950001	

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7. Software History

7.1 Q067, Type 100

Version	Change	Serial Number
P01	Introduction	330001
P05	Change from P04	630186
P06	Change from P05	830001
P07	Change from P06	1030015
P08	Joystick software introduced	550117

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7.2 Q068, Type 300 (12V)

Version	Change	Serial Number
P01	Introduction	330001
P05	Change from P04	630186
P06	Change from P05	830001
P07	Change from P06	1030015
P08	Joystick software introduced	550117

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7.3 Q069, Type 300 (24V)

Version	Change	Serial Number
P01	Introduction	330001
P05	Change from P04	630046
P06	Change from P05	830001
P07	Change from P06	1030100
P08	Joystick software introduced	550045

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8. Spares Numbers

8.1 Q067, Type 100

Item	Catalogue Number	Comments
Fuse Kit	D209	
12V CPU PCB	Q062	
12V CPU Transistor Kit	Q065	
12V CPU Assembly	Q067	
Type 100 CPU Software Kit	Q108	

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8.2 Q068, Type 300 (12V)

Item	Catalogue Number	Comments
Fuse Kit	D209	
12V CPU PCB	Q063	
CPU Transistor Kit	Q066	
12V CPU Assembly	Q068	
Type 300 CPU Software Kit	Q108	

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8.3 Q069, Type 300 (24V)

Item	Catalogue Number	Comments
Fuse Kit	D209	
24V CPU PCB	Q064	
CPU Transistor Kit	Q066	
24V CPU Assembly	Q069	
Type 300 CPU Software Kit	Q108	

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9. Circuit Description

Note that the electrical difference between the Type 100 and Type 300 (12V) computers is in the power stage of the motor drive circuits. The Type 100 uses IRF Z34 FETs or equivalents, and the Type 300 (12V) uses the more powerful SMP60N06 - 18 or equivalents.

The Type 300 (24V) also uses SMP60N06 - 18 FETs or equivalents.

9.1 Power Supplies

Type 100 and Type 300 (12V)

Refer to Figure 4, Block Diagram (Power Circuits) and Figure 10, Type 100 and Type 300 (12V) Circuit Diagram.

A nominal 12V is applied to V+ and V- pins of terminal block 1 (TB1).

Varistor V1 gives protection against transients and over - voltage.

After passing through link LK1 the supply is called V12 and is routed to:

1. IC1, a regulator which generates 5V for the logic circuits and reset signals for the microcontroller
2. Via fuse FS1 to SeaTalk terminal blocks TB4 and TB12
3. Diode D9, to become VBUS at D9 cathode.

VBUS is applied to:

1. R131/ZD3 to produce a 6.8V supply to the analogue - to - digital circuit (IC3a, IC3b)
2. NMEA OUT buffer (TR12, 13, 14 and 15) to give the correct NMEA signal level at TB6
3. TR3 to provide the correct SeaTalk output signal level at TBs 4 and 12
4. Rate Gyro and Roll Gyro via TBs 9 and 10 respectively.

If the supply polarity is correct, incoming 12V is passed through protection diode D19, and is applied as VPOWER to the clutch and motor drive circuits.

VPOWER is applied to FETs TR20 and TR21 through link LK3. Signal P3.4 is applied to TR18 which, with TR19, drives FETs TR20 and TR21 to produce supply VDBL via C17. VDBL is up to 12V higher (maximum voltage is limited by Zener diode ZD2) than VPOWER. This supply is applied to transistors TR22 and TR28 to ensure that FETs TR23 and TR27 are turned hard on when required by microcontroller signals P1.6 and P1.7.

FETs TR23, TR26, TR27 and TR29 are arranged in a conventional bridge network to supply motor drive power via TB8.

Clutch energisation is provided by FET TR38 via TB7. Drive transistor TR39 is supplied with VDBL to ensure that TR38 is turned on hard as required by microcontroller signal HP - ENABLE. VPOWER is fed to TR38 through link LK3 in these versions of the PCB.

Resistor R82 and Zener diode ZD1 provide supply VREG to the motor drive transistors TR25 and TR30 to ensure that the gate voltage of FETs TR26 and TR29 never exceeds 12V.

The +5V supply is used by resistor chain R19, R20, R21 and R119 to produce VREF, which is supplied to AD convertor IC3 as an input reference and to the fluxgate compass via TB11 as coil bias.

Relay Energisation

Figure 10, Type 100 and Type 300 (12V) Circuit diagrams and Figure 4, Power Circuit Block Diagram, contain relay energisation circuits used on:

Q068: PCB Serial Numbers below 0440028

Q067: PCB Serial Numbers below 0540001

The clutch is energised by signal HP - ENABLE from the microcontroller, and TR2 provides RLY - 0V which energises RL1. The contacts of RL1 short out D19 allowing current to flow to the bridge circuit with minimal voltage loss. When the clutch is de - energised, RL1 is also de - energised and the relay contacts open.

Relays RLY2 and RLY3 provide isolation for the PCB circuitry in the event that power is connected to the motor terminals by mistake.

RLY - 0V also energises relays RLY 2 and RLY 3, closing the relay contacts and allowing motor drive power onto the terminal block.

The contacts of RLY 2 and RLY 3 are opened when the clutch is de - energised.

Figure 5 shows the modifications to the Circuit and Block Diagrams on PCBs with serial numbers greater than 0440029 (Q068) and 0540001 (ZQ067) where energisation of the relays is immediate on application of the correct polarity supply voltage.

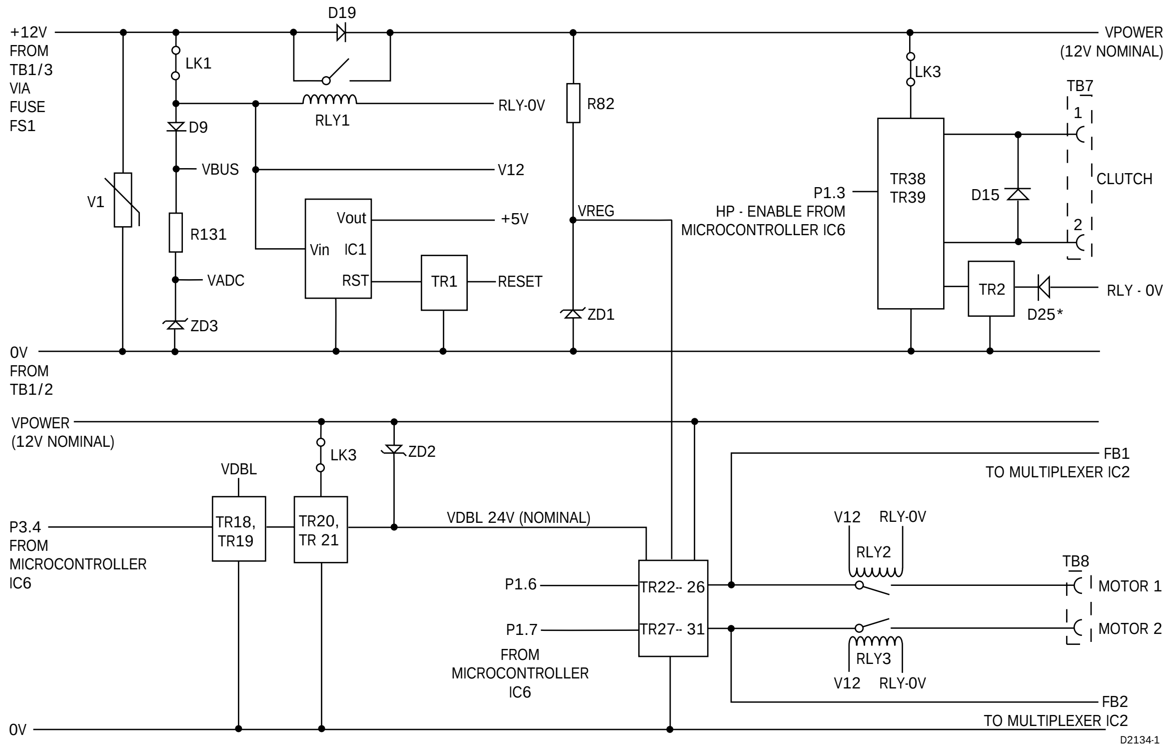

Figure 4 Block Diagram of 12V Power Circuits, Type 100 (Q067) and Type 300 (Q068)
D25* See Figure 5 for change to generation of RLY - 0V

Signal Flow is left to right except where indicated

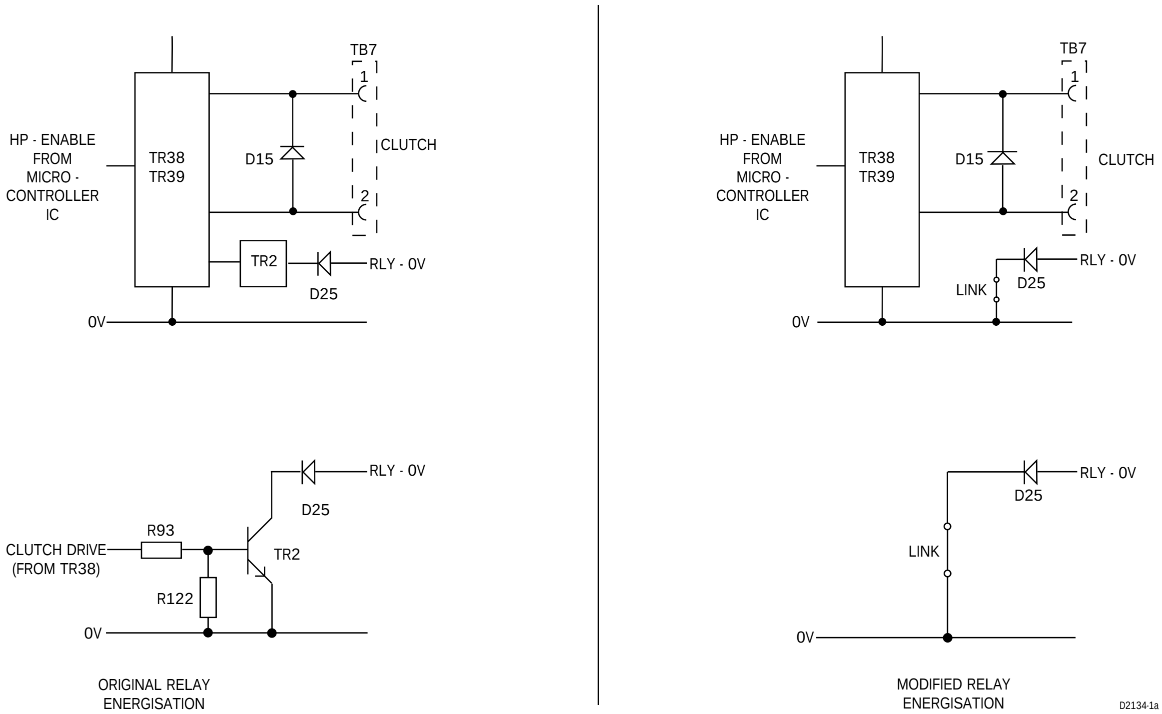

Figure 5 Generation of RLY - 0V

Type 300 (24V)

Refer to Figure 6, Block Diagram (Power Circuits) and Figure 11, Type 300 (24V) Circuit Diagram.

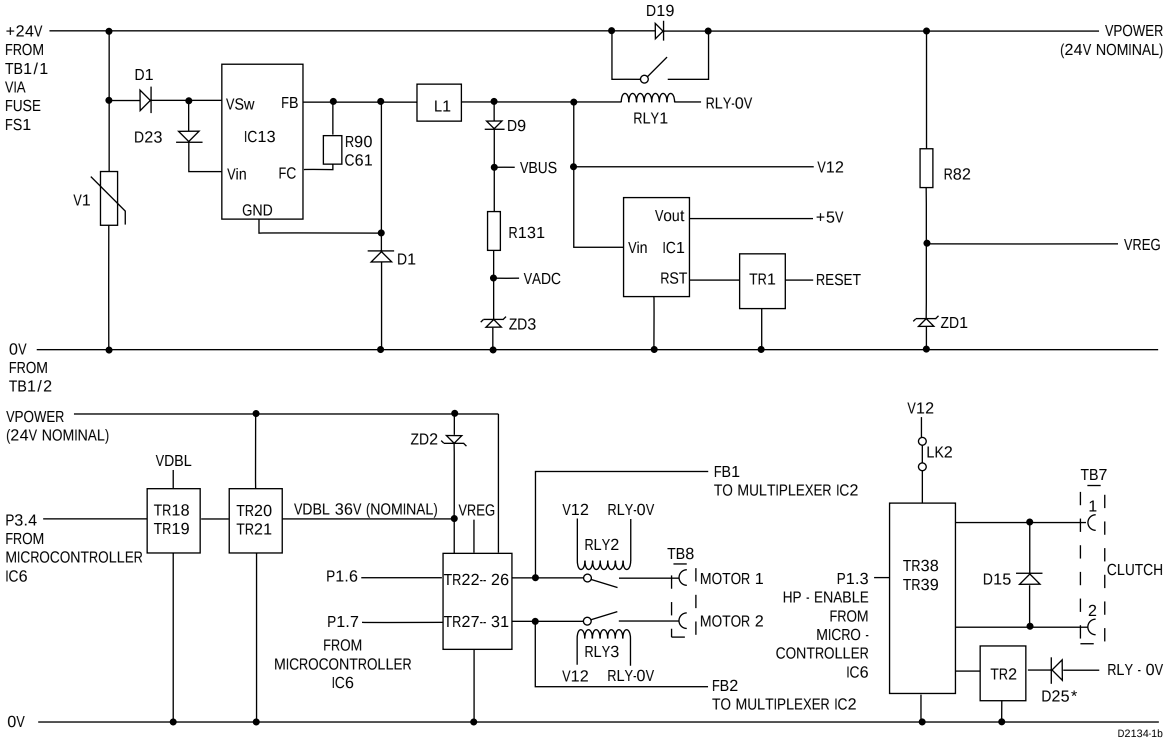

Figure 6 Block Diagram of 24v Power Circuits Type 300 (Q069)
Signal Flow is left to right except where indicated. D25* See Figure 5 for change to generation of RLY - 0V.

VBUS, V12, VADC, VREG and VRESET are the same as the 12V versions. The differences are:

1. V12 is generated by switching regulator IC13
2. VPOWER is 24V (nominal)
3. VDBL is 36V (nominal)
4. Clutch drive transistor TR38 is supplied with 12V through link LK2
5. Links LK1 and LK3 are open, and link LK2 supplies 12V to FET TR38 to control the clutch.

Diode protection of the clutch and motor drive circuits against reverse polarity supplies is as for the 12V versions.

Relay Energisation

Relay energisation is the same as Type 100 and Type 300 (12V). Figure 11, Type 300 Circuit Diagram, and Figure 6, Power Circuit Block Diagram show the method used for PCBs with serial numbers below 0440127. Figure 5 shows the modifications to Circuit and Block diagrams for PCBs with serial numbers greater than 0440127.

9.2 Signal Processing

External Signals

Refer to Figure 7, Block Diagram (Logic Circuits) and either Figure 10 or Figure 11, Type 100 and 300 (12V) and Type 300 (24V) respectively. Signal and processing circuits are identical for all three versions.

Fluxgate Compass

Compass Drives (1 and 2) are provided at TB11 by TR32 and TR33.

VRESET on TB11 provides a bias voltage to the compass coils.

Compass outputs F/GA and F/GB are routed via TB11 to analogue multiplexer IC2.

Rate Gyro and Roll Gyro

Both gyros are supplied with VBUS (nominal 12V) through TB9 (Rate) and TB10 (Roll). Gyro outputs are fed from the respective TBs to analogue multiplexer IC12.

Rudder Reference

The Rudder Reference transducer is supplied with 5V through TB2. The reference output is routed via TB2 to analogue multiplexer IC12.

Joystick

The Joystick is supplied with 5V through TB3. The joystick output is routed via TB3 to analogue multiplexer IC12.

SeaTalk

SeaTalk data passes through TB4 and/or TB12. Selection of SeaTalk input/output is made by microcontroller signal P1.4 .

Incoming data is applied to TR10/11 and hence to microcontroller inputs.

Outgoing data is generated at microcontroller output P3.1 and is applied to TR4, TR5, TR6 and TR7 to provide the 12V signal level of the SeaTalk system.

NMEA

Selection of NMEA output is made by microcontroller signal P1.5.

Incoming data on TB5 is applied to optocoupler IC4 and hence to microcontroller inputs.

Outgoing data is generated at microcontroller output P3.1 and is applied to TR12, TR13, TR14 and TR15 to provide the NMEA 12V signal level at TB6.

Internal Signals

Input signals from external instruments (compass etc.) are applied to analogue multiplexers IC2 and IC12. Selection of the signal for application to the A/D convertor IC3 is made by signals SEL A, SEL B, SEL C in combination with INHIBIT A and INHIBIT B. Selection signals are generated by Channel Select IC10 using data from the microcontroller.

The microcontroller accesses RAM, EPROM and EEPROM to store/retrieve program and factory - set calibration parameters.

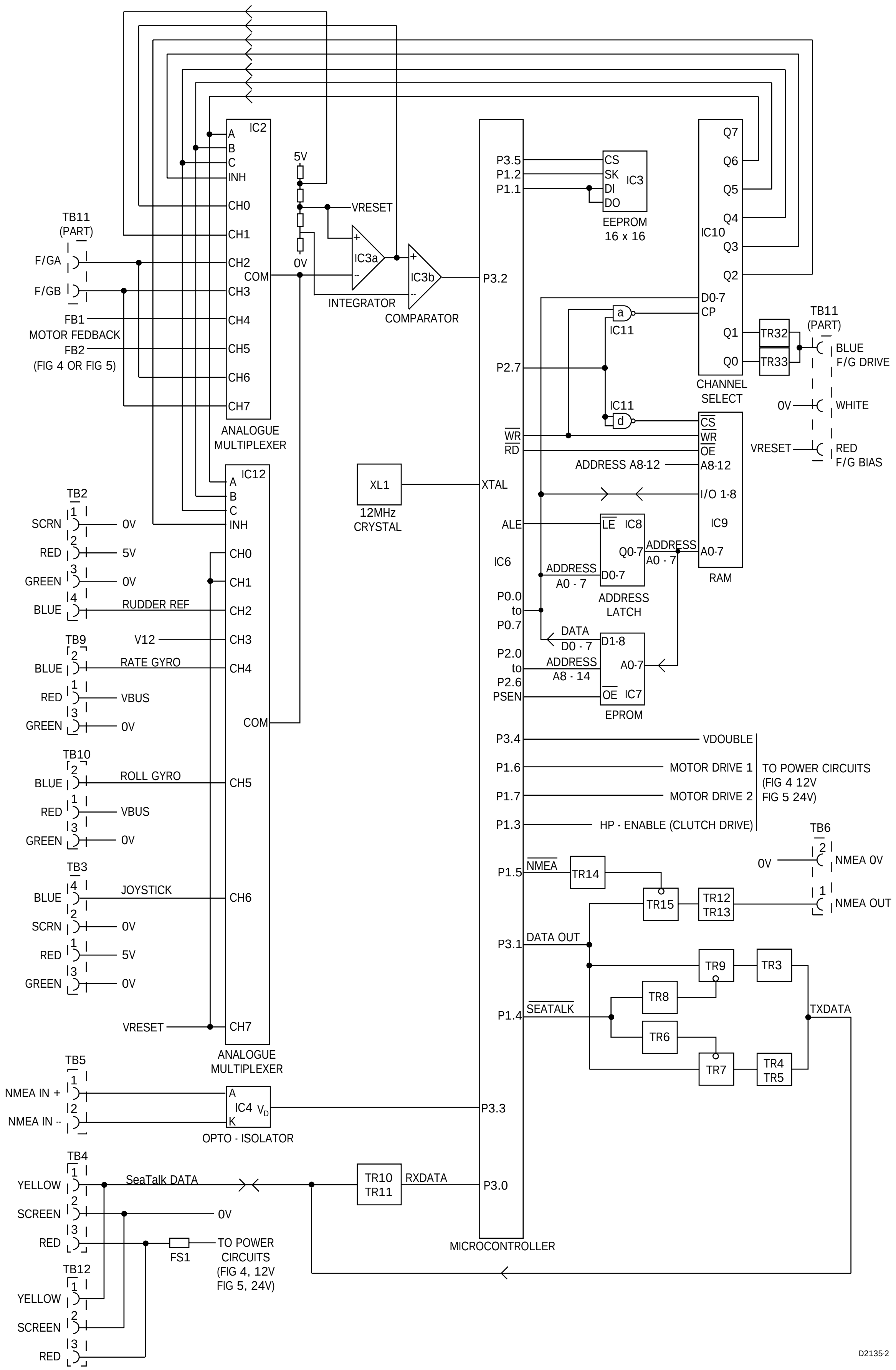

Figure 7 Logic Circuits Block Diagram, All Variants
Signal Flow is left to right except where indicated

9.3 Input/Output Signals

Terminal Block	Colour/ Label	Signal	Parameters	Dir
1	Power +	+V	+12V or +24V (nominal) DC	In
	Power -	0V	DC	In
2	Screen	0V	DC	Out
	Red	+5v	DC	Out
	Green	0v	DC	Out
	Blue	Rudder Ref'ce	0 to 5V variable DC	In
3	Screen	0V	DC	Out
	Red	+5V	DC	Out
	Green	0V	DC	Out
	Blue	Joystick Output	0 to 5V variable DC	In
4	Yellow	SeaTalk Data	Irregular trains of 12V pulses	In/Out
	Red	+12V	DC	Out
	Screen	0V	DC	Out
5	NMEA+	NMEA In+	Irregular trains of 12V pulses	In
	NMEA-	NMEA In-	0V	In
6	NMEA+	NMEA Out+	Irregular trains of 12V pulses	Out
	NMEA-	NMEA Out-	0V	Out
7	CLUTCH+	Clutch +	Irregular variable length 12V pulses	Out
	CLUTCH -	Clutch -	0V	Out
8	MOTOR 1	Motor 1	Irregular variable length pulses, 12V or 24V, dependent on variant	Out
	MOTOR 2	Motor 2	Irregular variable length pulses, 12V or 24V, dependent on variant	Out

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Input/Output Signals (ctd)

Terminal Block	Colour/ Label	Signal	Parameters	Dir
9	Red	VBUS	+12V DC	Out
	Green	0V	DC	Out
	Blue	Rate Gyro O/P	0 to 12V DC	In
10	Red	VBUS	+12V DC	Out
	Green	0V	DC	Out
	Blue	Roll Gyro O/P	0 to 12V DC	In
11	Green	Compass Output F/GA	+2.5 DC	In
	Yellow	Compass Output F/GB	2.5 DC	In
	Red	VRESET	+2.5V DC	Out
	Blue	Compass Drive 1	AC signal, 17 cycles at 7.9KHz, driven twice every 1/16 second	Out
	White	Compass Drive 2	0V	Out
12	Yellow	SeaTalk Data	Irregular trains of 12V pulses	In/Out
	Red	+12V	DC	Out
	Screen	0V	DC	Out

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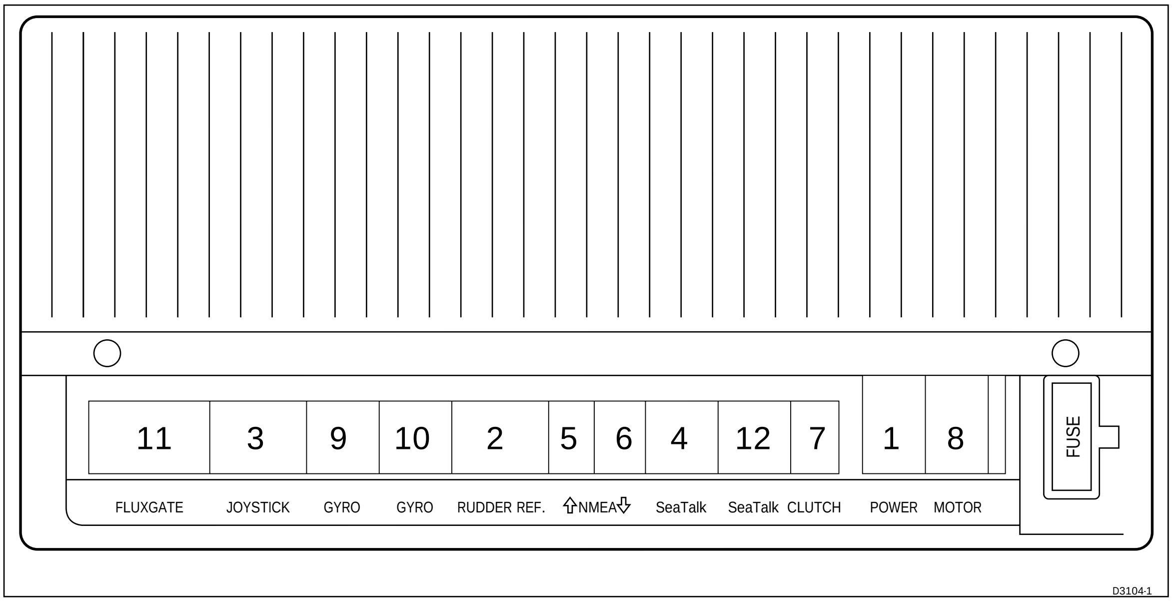
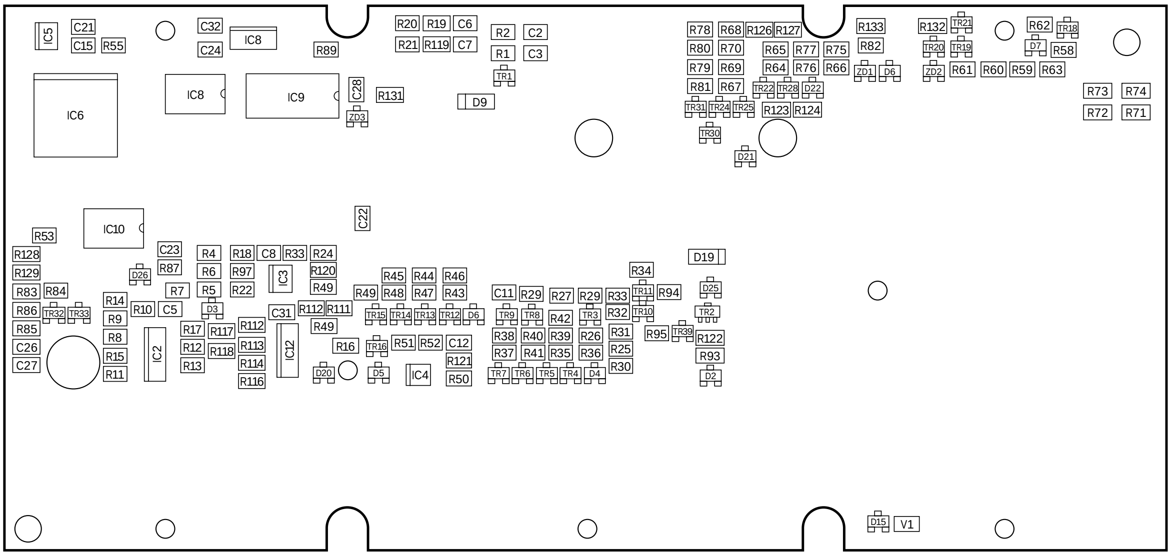


Figure 8 Terminal Block Numbering

10. PCB Layouts and Component Lists

10.1 12V Computers, Type 100 (Q067) and Type 300 (Q068)



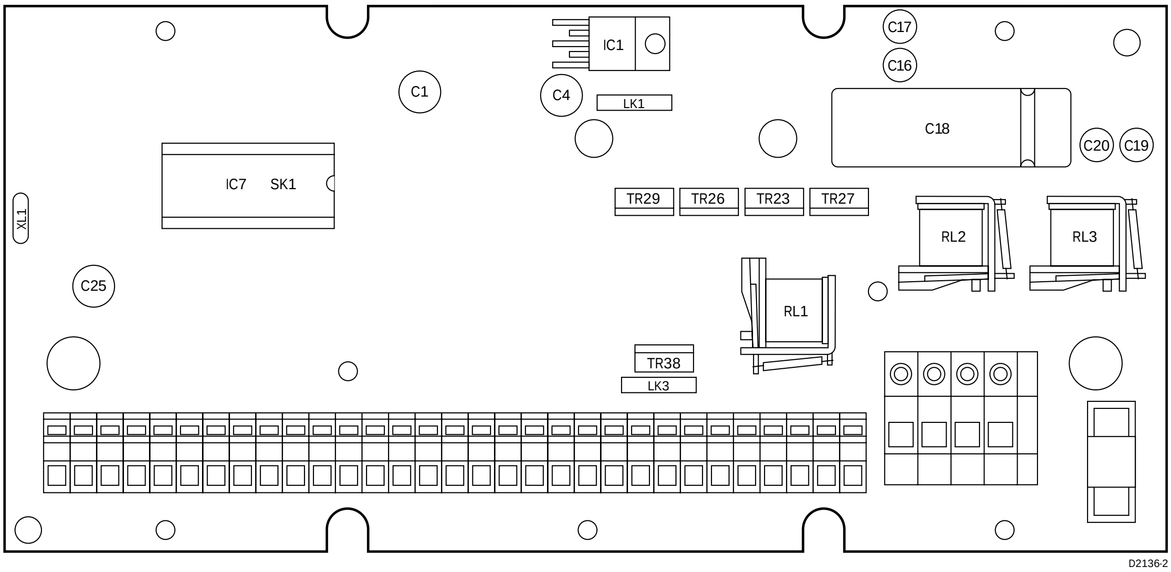


Figure 9 PCB Layout Type 100 (Q067) and Type 300 12V (Q068)

Figure 10 Circuit Diagram 12V Computers, Type 100 (Q067) and Type 300 (Q068)
(See Parts List for differences)

Figure 11 Circuit Diagram, 24V Computer Type 300 (Q069)

10.2 24V Computer, Type 300 (Q069)

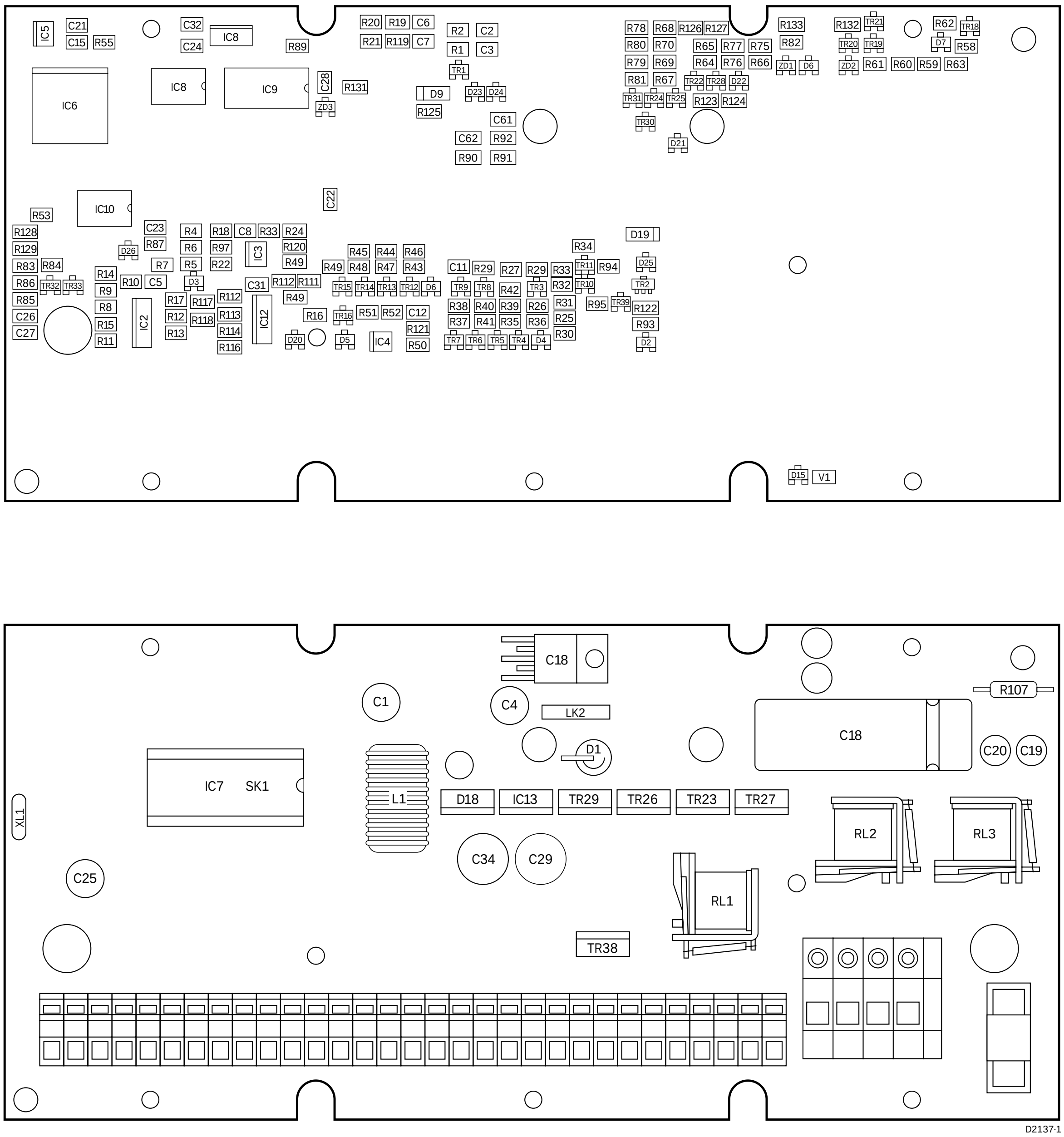


Figure 12 PCB Layout, Type 300 24V (Q069)

10.3 PCB Components, Type 100 12V (Q067) and Type 300 12V (Q068)

Surface Mount

RESISTOR 8R2 5% 125mw	R36, 55, 85, 86, 89, 132, 133
RESISTOR 47R 55 125mW	R43
RESISTOR 82R 1% 125mw	R20
RESISTOR 270R 1% 125mw	R8, 9, 82, 119
RESISTOR 390R 5% 125mw	R26, 37, 38, 40, 41, 48
RESISTOR 1K0 1% 125mw	R6, 7, 10, 11, 21, 111, 131
RESISTOR 1K2 1% 125mw	R19, 71, 72, 73, 74
RESISTOR 1K5 5% 125mw	R44, 83, 84, 93
RESISTOR 2K2 5% 125mw	R27, 35, 50, 67, 69, 79, 81, 121, 122, 128
RESISTOR 4K7 5% 125mw	R1, 32, 46, 47, 49, 52, 58, 61, 64, 65, 76, 77, 87, 95, 126, 127, 129
RESISTOR 5K6 1% 125mw	R4, 5, 16, 18, 97, 110, 112, 116, 123, 124
RESISTOR 10K 5% 125mw	R2, 14, 15, 23, 24, 29, 34, 39, 42, 45, 51, 59, 60, 68, 80, 113, 114
RESISTOR 15K 5% 125mw	R30, 66, 70, 75, 78
RESISTOR 22K 5% 125mw	R28
RESISTOR 33K 1% 125mw	R17, 94, 117
RESISTOR 39K 5% 125mw	R25, 31, 33
RESISTOR 68K 1% 125mw	R12, 13, 22, 62, 63, 115, 118
RESISTOR 820K 5% 125mW	R120
RESISTOR 1M0 1% 125mw	R53
CAPACITOR 22nF 5% X7R 1206 50V	C3
CAPACITOR 1000pF 2% COG 50V	C8
CAPACITOR 1000pF 5% COG 50V	C11

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Surface Mount Type 100 12V (Q067) and Type 300 12V (Q068) (ctd)

CAPACITOR 0.1uF 20% X7R 1206 50V	C2, 5, 6, 7, 12, 15, 21, 22, 23, 24, 26, 28, 31, 32, 33
CAPACITOR TANTALUM 2.2uF	C27
DIODE SOT23 BAS19	D2, 5, 6, 7, 15, 20, 25, 26
DIODE SOT23 BAV70	D21, 22
DIODE SOT23 BAV99	D4, 8
DIODE SOT23 BAW 56	D3
ZENER DIODE BZX12V	ZD1, 2
ZENER DIODE SOT23 BZX6V8	ZD3
RECTIFIER DIODE 1A 100V	D9, 19
TRANSISTOR BC807 SOT23 PNP	TR3, 12, 32
TRANSISTOR BC817 SOT23 NPN	TR1, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 18, 19, 22, 24, 25, 28, 30, 31, 33, 39
TRANSISTOR BC868 SOT89 NPN	TR2
TRANSISTOR 2N7002	TR20, 21
74HC4051	IC2, 12
DUAL OP AMP TLC272	IC3
OPTO - COUPLER PC317	IC4
EEPROM 9306	IC5
MICROCONTROLLER 80C32	IC6
8 - BIT LATCH 74HC373	IC8
8K RAM HM6264A	IC9
8 - BIT LATCH 74HC374	IC10
QUAD 2 - INPUT NOR 74HC02	IC11
VARISTOR VC1206260540	V1

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Conventional Components, Type 100 12V (Q067) and Type 300 12V (Q068)

CAPACITOR ELECTROLYTIC 1uF	C19, 20
CAPACITOR ELECTROLYTIC 10uF 25V	C16, 17
CAPACITOR ELECTROLYTIC 100uF 25V	C1, 4, 25
CAPACITOR ELECT'LYTIC 1000uF 63V	C18
FET (SEE NOTE)	TR23, 26, 27, 29
FET IRF Z34 60V 30A 50MOHM	TR38
5V REGULATOR WITH RESET LM2925	IC1
64K EPROM 27C512 200nS	IC7
RESONATOR THREE LEGGED	XL1
RELAY 12V 40A	RL1, 2, 3
FUSE HOLDER	1 off
LINK	LK1, LK3
IC SOCKET 28 PIN DIL	1 off
4 - WAY TERMINAL BLOCK	1 off
TERMINAL BLOCK	31 off
TERMINAL BLOCK END PLATE	1 off
LABEL (SEE NOTE)	1 off

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NOTE: Type 100 12V Q067: FET IRF Z34 60V 30A 5OMOHM and Red Dot Label

Type 300 12V Q068: FET 60N06 - 18 and White Dot Label

10.4 PCB Components, Type 300 24V (Q069)

Surface Mount

RESISTOR 8R2 5% 125mw	R36, 55, 85, 86, 89
RESISTOR 10R 1% 125mw	R125
RESISTOR 47R 5% 125mW	R43, 133
RESISTOR 82R 1% 125mw	R20
RESISTOR 270R 1% 125mw	R8, 9, 119
RESISTOR 390R 5% 125mw	R26, 37, 38, 40, 41, 48
RESISTOR 470R 5% 125mw	R90, 132
RESISTOR 1K0 1% 125mw	R10, 11, 21, 111, 131
RESISTOR 1K2 1% 125mw	R19, 91
RESISTOR 1K5 5% 125mw	R6, 7, 44, 83, 84, 93
RESISTOR 2K2 5% 125mw	R27, 35, 50, 67, 69, 79, 81, 121, 122, 128
RESISTOR 2K2 5% 125mw	R82
RESISTOR 4K7 5% 500mw	R1, 32, 46, 47, 49, 52, 58, 61, 64, 65, 76, 77, 87, 95, 126, 127, 129
RESISTOR 5K6 1% 125mw	R16, 18, 97, 110, 112, 116, 123, 124
RESISTOR 10K 5% 125mw	R2, 14, 15, 23, 24, 29, 34, 39, 42, 45, 51, 59, 60, 68, 80, 113, 114
RESISTOR 12K 5% 125mw	R92
RESISTOR 15K 5% 125mw	R30, 66, 70, 75, 78
RESISTOR 22K 5% 125mw	R28
RESISTOR 33K 1% 125mw	R4, 5, 12, 13, 17, 94, 117
RESISTOR 39K 5% 125mw	R25, 31, 33
RESISTOR 68K 1% 125mw	R22, 62, 63, 96, 115, 118
RESISTOR 820K 5% 125mW	R120
RESISTOR 1M0 1% 125mw	R53
CAPACITOR 22nF 5% X7R 1206 50V	C3
CAPACITOR 1000pF 2% COG 50V CAPACITOR 1000pF 5% COG 50V	C8 C11

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Surface Mount Type 300 24V (Q069) (ctd)

CAPACITOR 0.1uF 20% X7R 1206 50V	C2, 5, 6, 7, 12, 15, 21, 22, 23, 24, 26, 28, 31, 32, 33
CAPACITOR TANTALUM 1uF 16V SIZE A	C61, 62
CAPACITOR TANTALUM 2.2uF	C27
DIODE SOT23 BAS19	D2, 5, 6, 7, 15, 20, 23, 24, 25, 26
DIODE SOT23 BAV70	D21, 22
DIODE SOT23 BAV99	D4, 8
DIODE SOT23 BAS19	D2, 5, 6, 7, 15, 20, 25, 26
DIODE SOT23 BAV70	D21, 22
DIODE SOT23 BAV99	D4, 8
DIODE SOT23 BAW 56	D3
ZENER DIODE BZX12V	ZD1, 2
ZENER DIODE SOT23 BZX6V8	ZD3
RECTIFIER DIODE 1A 100V	D9, 19
TRANSISTOR BC807 SOT23 PNP	TR3, 12, 32
TRANSISTOR BC817 SOT23 NPN	TR1, 4 - 11, 13 - 16, 18, 19, 22, 24, 25, 28, 30, 31, 33, 39
TRANSISTOR BC868 SOT89 NPN	TR2
TRANSISTOR 2N7002	TR20, 21
74HC4051	IC2, 12
DUAL OP AMP TLC272	IC3
OPTO - COUPLER PC317	IC4
EEPROM 9306	IC5
MICROCONTROLLER 80C32	IC6
8 - BIT LATCH 74HC373	IC8
8K RAM HM6264A	IC9
8 - BIT LATCH 74HC374	IC10
QUAD 2 - INPUT NOR 74HC02	IC11
VARISTOR VC1206260540	V1

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Conventional Components, Type 300 24V (Q069)

RESISTOR 270R 5% 500mW	R107
CAPACITOR ELECTROLYTIC 1uF	C19, 20
CAPACITOR ELECTROLYTIC 10uF 25V	C17, 17, 30
CAPACITOR ELECTROLYTIC 470uF 55V	C29
CAPACITOR ELECTROLYTIC 100uF 25V	C1, 4, 25
CAPACITOR ELECTROLYTIC 1000uF 16V	C34
CAPACITOR ELECTROLYTIC 1000uF 63V	C18
DIODE MR751	D1
DIODE FAST RECOVERY PBYR1645	D18
FET SMP 60N06 - 18	TR23, 26, 27, 29
FET IRF Z34 60V 30A 50MOHM	TR38
5V REGULATOR WITH RESET LM2925	IC1
SWITCH MODE REGULATOR LT1270	IC13
64K EPROM 27C512 200nS	IC7
RESONATOR THREE LEGGED	XL1
INDUCTOR 100uH 8A	L1
RELAY 12V 40A	RL1, 2, 3
FUSE HOLDER	1 off
LINK	LK2
IC SOCKET 28 PIN DIL	1 off
4 - WAY TERMINAL BLOCK	1 off
TERMINAL BLOCK	31 off
TERMINAL BLOCK END PLATE	1 off
BLUE DOT LABEL	1 off

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