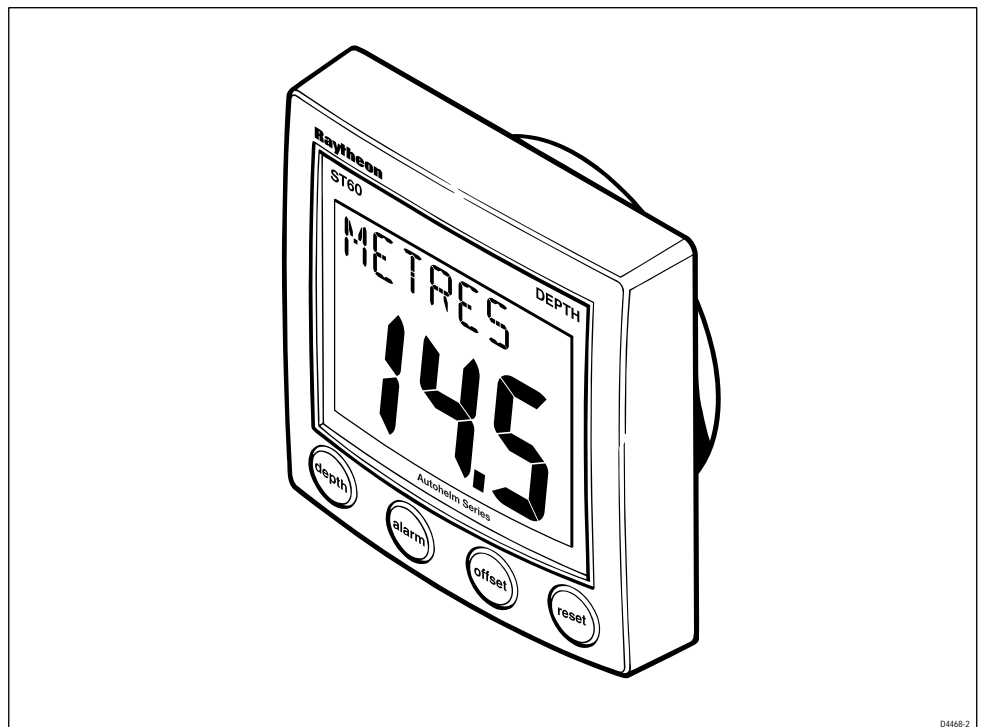


Part 1. ST60 Digital instruments



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ST60 Digital instrument exploded view

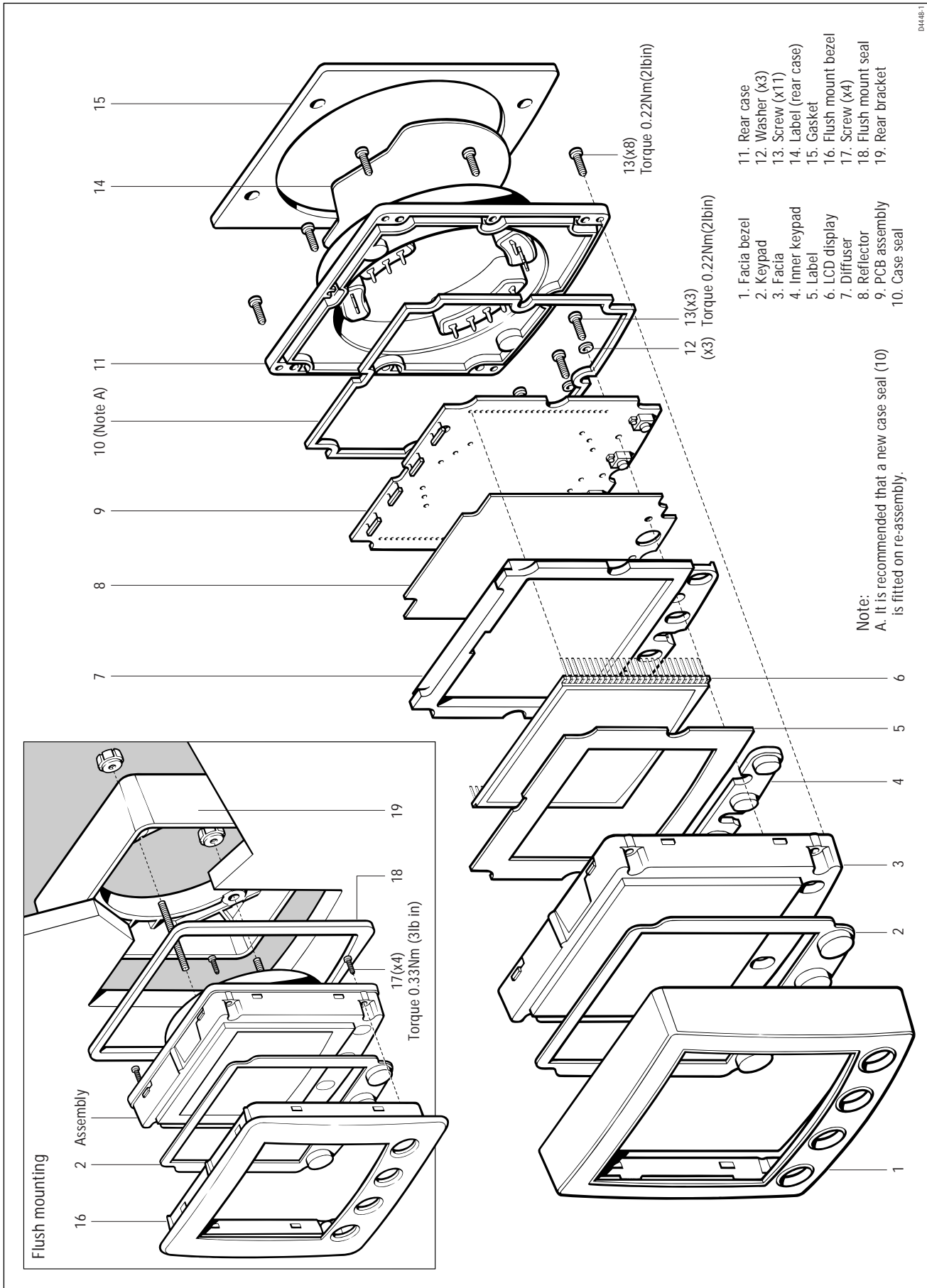


Figure 1: ST60 Speed, Depth, Multi and Tridata Digital Instrument exploded view

Chapter 1. ST60 Speed instrument

Disassembly/reassembly

On reassembly (refer to Figure 1), it is important that the PCB assembly module is fixed to the facia (3) using a torque of 0.22Nm (2lb in). Similarly, fixing the rear case (11) to the facia (3) must also be torqued to 0.22Nm (2lb in).

Note: Failure to practice using the recommended torques may result in damage to the facia inserts. It is also recommended a new case seal (10) is fitted on reassembly.

Self-test procedure

The ST60 Speed instrument has built-in self-test functions to aid fault diagnosis.

To access self-test mode, press Key 1 and Key 4 together for 4 seconds. When the unit beeps, immediately press Key 3 and Key 4 together momentarily. The unit will enter self-test stage 1.

Self test stage 1

- A. The unit should display “TEST1”
- B. Audible Beep for 1 second.
- C. There will be a SeaTalk transmission to check the transmit/receive circuits.
- D. The EEPROM is tested.

The following failure codes may be generated:

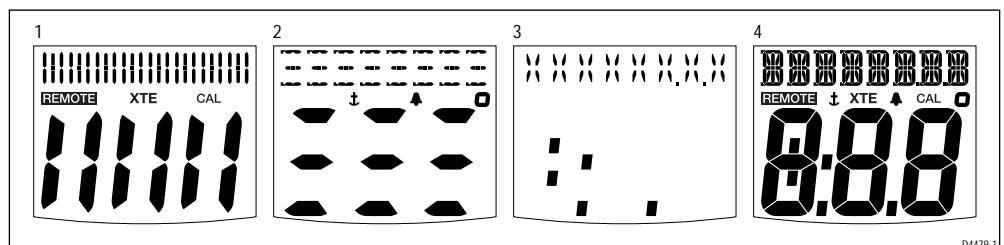
Message	Failure Mode	Action
FAIL 1	SeaTalk Rx/Tx	Check for damaged bucket connectors/rear-case pins. Check SeaTalk interface components around TR1, TR2 and TR3.
FAIL 2	EEPROM failure	Replace EEPROM (IC2)

If there is no audible beep, check TR11 and RN3 and the buzzer for damage. If the beep is quiet, check R21.

If all test pass, “PASS” is shown on the display. Press Key 1 and Key 2 together momentarily to progress to self-test stage 2.

Self-test stage 2

- A. The unit should display “TEST 2” for 1 second.
- B. Illumination will change between level 0 and level 3 every second.
- C. Any key press sound cause audible beep.
- D. LCD segments will cycle through the following sequence:



No fail codes are generated since stage 2 is an audio/visual check. The following can, however, be used as a guide to isolate a problem:

Failure Mode	Action
No illumination	Check TR14, TR13, TR15 and associated components. Check all LEDs.
Keypad illumination failure (LCD illumination will also be degraded)	Check TR14, TR13, R22 and R23. Check LED1-6 for open circuit.
Keypad illumination OK but degraded LCD illumination	Check TR14, TR15, RN3, R24. Check LED 7 and 8 for open circuit.
No beep when key pressed	Replace keyswitch.
LCD segment(s) missing completely	Check LCD solder pins for poor/dry joints. Check IC3 for unsoldered pins.
Faint LCD segments	Check LCD pins for shorts. Check IC3 for shorts.

Press Key 1 and Key 2 together momentarily to progress to self-test stage 4 (stage 3 not supported on this instrument).

Self-test stage 4

Note: A known good transducer must be connected for this test.

- A. The unit should display ‘TEST 4’ for 1 second.
- B. Transducer test is performed.

Spin the paddle wheel within 15 seconds of entering this test. If the interface is working correctly, “PASS” will be shown. Otherwise “FAIL 10” is shown.

If the test fails, do the following:

Check	Failure Mode	Action
Voltage at 12V_SPD	No voltage or low voltage (<11.0) with 12V battery supply.	Check TR17, TR20, R63 and R64.
L7	Open circuit	Replace L7
D3	Open circuit	Replace D3
Voltage at TEMP pin	Outside acceptable range of 0.76 to 1.00V (18 - 25 degrees C)	Check L9 for open circuit Check R14
AVREF	Outside acceptable range of 2.5V +/- 0.25v	Check TR4. Check R74, 17

Press Key 1 and Key 2 together momentarily to exit self-test.

ST60 Speed spare parts list

The **item** numbers refer to

Figure 1: ST60 Digital instrument exploded view

Item	Spare/Accessory Description	Part No.	Comments
1	Facia bezel	A25001	
–	Suncover, standard	A25004	Not illustrated
2	Keypad, Speed	A28019	Pack of 5
	Facia with case seal, <i>including</i>	A28013	
3	Facia		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
	Inner keypad, <i>including</i>	A28022	
4	Inner keypad		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
5	Display label, Speed	A28031	Pack of 5
6	LCD display, Speed	A28023	Also serves the Depth or Multi
	PCB assembly, Speed, <i>including</i>	A28010	Assembled module consisting of items 6, 7, 8, 9.
6	LCD display, Speed		See A28023
7	Diffuser		
8	Reflector		
9	PCB assembly, Speed		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
10	Case seal	A28027	Pack of 5
	Rear case assembly, <i>including</i>	A28014	
10	Case seal		See A28027
11	Rear case		
13	Screw (x8)		Torque to 0.22Nm (2lb in)
14	Label, Speed (rear case)	A28035	Pack of 5
15	Gasket	A28028	Pack of 5
16	Flush mount bezel	A25002	
	Flush mount kit, <i>including</i>	A25003	
–	Suncover, flush mount		Not illustrated
16	Flush mount bezel		See A25002
17	Screw (x4)		Torque to 0.33Nm (3lb in)
18	Flush mount seal		
19	Rear bracket		

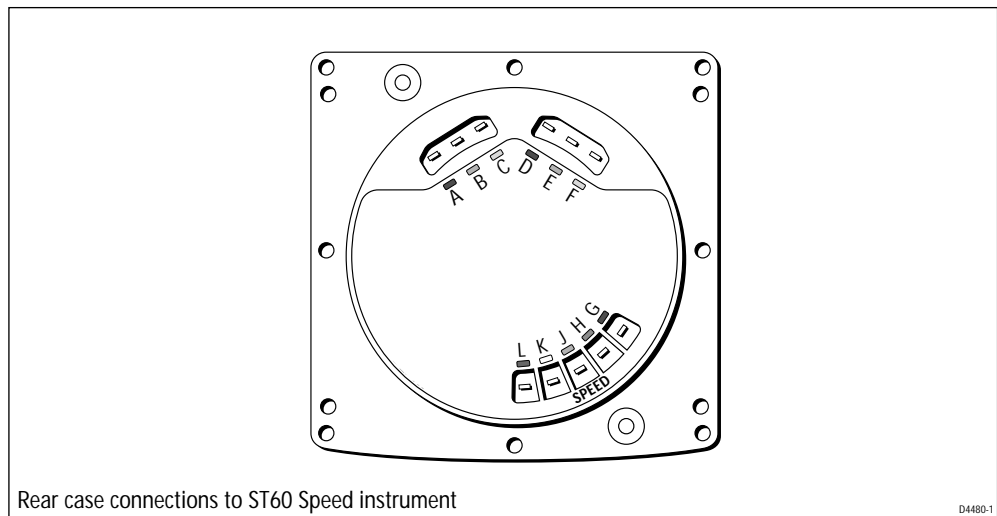
A22001

ST60 Speed PCB details

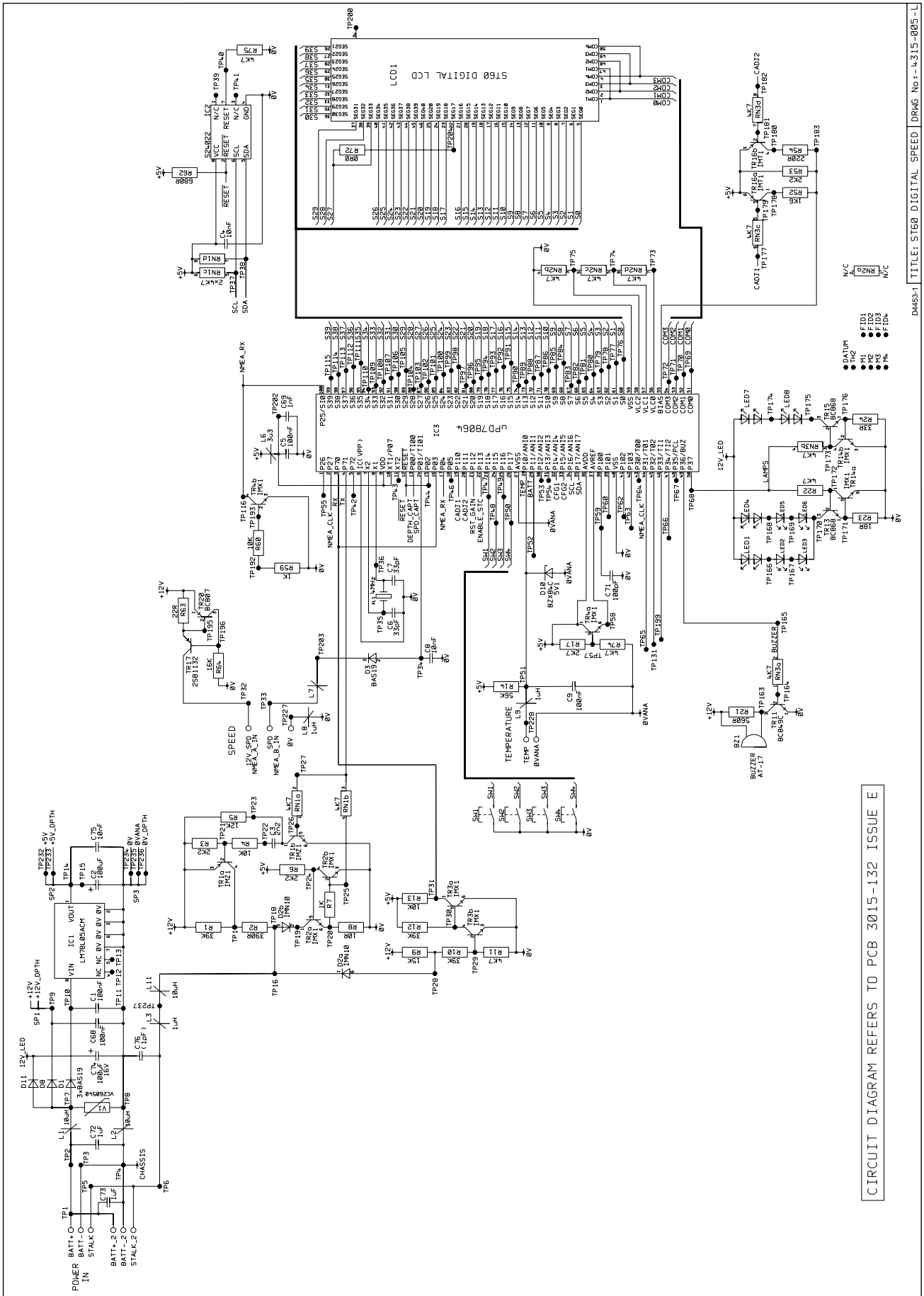
Input/Output signals

(refer to Figure 2. ST60 Speed circuit diagram)

Rear case connection	Signal	Description
A (Red)	BATT+_2	Nominal 12V DC supply
B (Screen)	BATT-_2	OV
C (Yellow)	STALK_2	Intermittent streams of (nominal) 12V pulses
D (Red)	BATT+	Nominal 12V DC supply
E (Screen)	BATT-	OV
F (Yellow)	STALK	Intermittent streams of (nominal) 12V pulses
G (Red)	12V_SPD	Approximately 11.2V DC out
H (Green)	SPD	With transducer attached, spinning paddle-wheel produces pulses approximately 11.2V DC in amplitude @ 5.5Hz/Knot.
J (Screen)	OV	OV
K (White)	TEMP	With transducer attached, voltage here is dependant on temperature. Approximately 1.8v at 0 degrees C.
L (Brown)	OVANA	OV



ST60 Speed circuit diagram



D4463-1 TITLE: ST60 DIGITAL SPEED DRWG No: -L315-005-1-

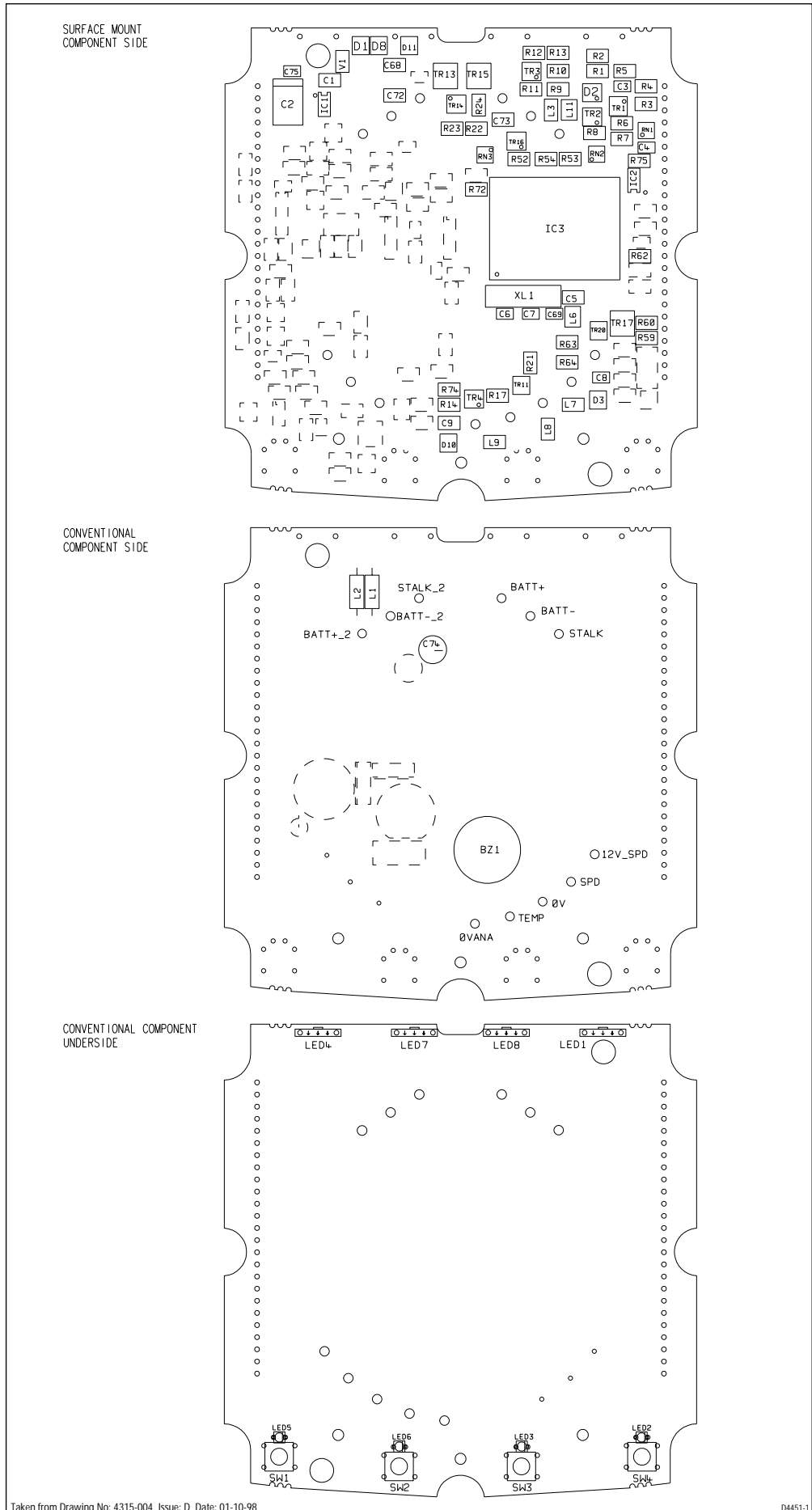
A22001

CIRCUIT DIAGRAM REFERS TO PCB 3015-132 ISSUE E

Figure 2. ST60 Speed circuit diagram

A22001

ST60 Speed PCB layout



Taken from Drawing No: 4315-004 Issue: D Date: 01-10-98

D4451-1

ST60 Speed PCB component list

SURFACE MOUNT COMPONENT SIDE

96004MHZ	1	CRYSTAL 4MHZ	XL1
9600L13	1	CHIP INDUCTOR 3U3 1210	L6
9600L3	1	CHIP INDUCTOR 10uH 1210	L11
9600L1	4	SOLID CHIP INDUCTOR	L3,7-9
9108VC260540	1	VARIATOR VC260540	V1
940078064	1	IC MICROPROCESSOR uPD78064	IC3
940024022	1	IC EEPROM/RESET S24022	IC2
9400LM78L05	1	IC REGULATOR 78L05 5V S08	IC1
95002B1132	1	TRANSISTOR SOT89 PNP 2SB1132	TR17
95001MT1	1	TRANSISTOR SOT36 DUAL PNP 1MT1	TR16
95001MX1	4	TRANSISTOR SOT36 DUAL NPN 1MX1	TR2-4,14
95001MZ1	1	TRANSISTOR SOT36 DUAL NPN/PNP 1MZ1	TR1
9501BC868	2	TRANSISTOR SOT89 BC868 MULLARD	TR13,15
9500BC849C	1	TRANSISTOR SOT23 BC849C	TR11
9500BC807	1	TRANSISTOR SOT23 BC807 MULLARD	TR20
93261U	2	CAPACITOR 1uF 20% 50V 1206	C72,73
93BDHXX2N2	1	CAPACITOR X7R 2N2 50V 0805	C3
93040U01	3	CAPACITOR CER 10nF 10% 50V 0805	C4,8,75
930133P	2	CAPACITOR CER 33pF 0805	C6,7
93041000P	1	CAPACITOR CER 1000pF 10% 50V 0805	C69
93070U1	4	CAPACITOR CER 0.1uF 20% 50V 1206	C1,5,9,68
9320100U	1	CAPACITOR TANT 100uF 10V TANTE	C2
9203BZX84C5V1	1	DIODE ZENER 5V1 SOT23	D10
92061MN10	1	DIODE TRIPLE ARRAY 1MN10	D2
9200BAS19	4	DIODE BAS19 SOT23	D1,3,8,11
91124K7	3	RESISTOR NETWORK 4K7	RN1-3
910618R	1	RESISTOR WCR 1206 18R 5% 0.125W	R23
9106680R	1	RESISTOR WCR 1206 680R 5% 0.125W	R62
9103560R	1	RESISTOR WCR 1206 560R 1% 0.125W	R21
9106220R	1	RESISTOR WCR 1206 220R 5% 0.125W	R54
910622R	1	RESISTOR WCR 1206 22R 5% 0.125W	R63
91031K	2	RESISTOR WCR 1206 1K0 1% 0.125W	R7,59
910633R	1	RESISTOR WCR 1206 33R 1% 0.125W	R24
91060R0	1	RESISTOR WCR 1206 0R0 5% 0.125W	R72
91062K7	1	RESISTOR WCR 1206 2K7 5% 0.125W	R17
910656K	1	RESISTOR WCR 1206 56K 5% 0.125W	R14
910616K	1	RESISTOR WCR 1206 16K 5% 0.125W	R64
910612K	1	RESISTOR WCR 1206 12K 5% 0.125W	R5
9106390R	1	RESISTOR WCR 1206 390R 5% 0.125W	R2
910639K	3	RESISTOR WCR 1206 39K 5% 0.125W	R1,10,12
910310R	1	RESISTOR WCR 1206 10R 1% 0.125W	R8
91064K7	4	RESISTOR WCR 1206 4K7 5% 0.125W	R11,22,74,75
91031K6	1	RESISTOR WCR 1206 1K6 1% 0.125W	R52
91062K2	3	RESISTOR WCR 1206 2K2 5% 0.125W	R3,6,53
910615K	1	RESISTOR WCR 1206 15K 5% 0.125W	R9
910610K	3	RESISTOR WCR 1206 10K 5% 0.125W	R4,13,60
3015-132	1	PCB ST60 DIGITAL TRIDATA	

CONVENTIONAL COMPONENT SIDE

3030-035-C	11	SOLDER BUCKETS	
15136	1	BUZZER AT-17	BZ1
15341	2	INDUCTOR MINIATURE SC30 10uH 0.25W	L1,2
03065	1	CAPACITOR ELEC 100uF +80/-20% 16V	C74

CONVENTIONAL COMPONENT UNDERSIDE

06030	4	SWITCH ALPMIN TACTILE	SW1-4
15165	4	LED GREEN 2-CHIP	LED1,4,7,8
02050	4	LED GREEN HLMP6505	LED2,3,5,6

Taken from Drawing No: 4315-004 Issue: D Date: 01-10-98

D4452-1

A22001

Chapter 2. ST60 Depth instrument

Disassembly/reassembly

On reassembly (refer to Figure 1), it is important that the PCB assembly module is fixed to the facia (3) using a torque of 0.22Nm (2lb in). Similarly, fixing the rear case (11) to the facia (3) must also be torqued to 0.22Nm (2lb in).

Note: Failure to practice using the recommended torques may result in damage to the facia inserts. It is also recommended a new case seal (10) is fitted on reassembly.

Self-test procedure

The ST60 Depth instrument has built-in self-test functions to aid fault diagnosis.

To access self-test mode, press Key 1 and Key 4 together for 4 seconds. When the unit beeps, immediately press Key 3 and Key 4 together momentarily. The unit will enter self-test stage 1.

Self test stage 1

- A. The unit should display “TEST 1”
- B. Audible Beep for 1 second.
- C. There will be a SeaTalk transmission to check the transmit/receive circuits.
- D. The EEPROM is tested.

The following failure codes may be generated:

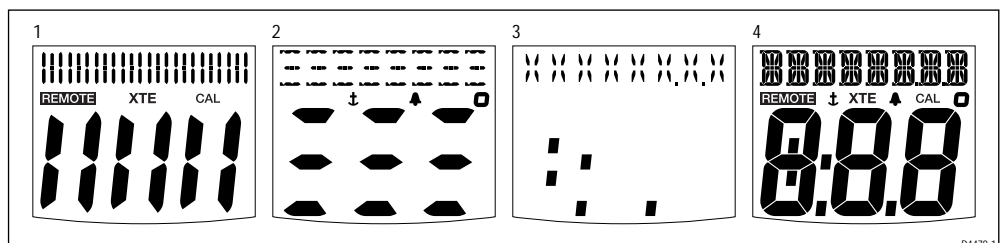
Message	Failure Mode	Action
FAIL 1	SeaTalk Rx/Tx	Check for damaged bucket connectors/rear-case pins. Check SeaTalk interface components around TR1, TR2 and TR3.
FAIL 2	EEPROM failure	Replace EEPROM (IC2).

If there is no audible beep, check TR11 and RN3 and the buzzer for damage. If the beep is quiet, check R21.

If all test pass, “PASS” is shown on the display. Press Key 1 and Key 2 together momentarily to progress to self-test stage 2.

Self-test stage 2

- A. The unit should display “TEST 2” for 1 second.
- B. Illumination will change between level 0 and level 3 every second.
- C. Any key press sound cause audible beep.
- D. LCD segments will cycle through the following sequence:



No fail codes are generated since stage 2 is an audio/visual check. The following can, however, be used as a guide to isolate a problem:

Failure Mode	Action
No illumination	Check TR14, TR13, TR15 and associated components. Check all LEDs.
Keypad illumination failure (LCD illumination will also be degraded)	Check TR14, TR13, R22 and R23. Check LED1-6 for open circuit.
Keypad illumination OK but degraded LCD illumination	Check TR14, TR15, RN3, R24. Check LED 7 and 8 for open circuit.
No beep when key pressed	Replace keyswitch.
LCD segment(s) missing completely	Check LCD solder pins for poor/dry joints. Check IC3 for unsoldered pins.
Faint LCD segments	Check LCD pins for shorts. Check IC3 for shorts.

Press Key 1 and Key 2 together momentarily to progress to self-test stage 4 (stage 3 not supported on this instrument).

Self-test stage 4

Note: For this test, a known good transducer must be connected and placed in water where an echo can be detected. Alternatively, an echo simulator can be used.

- A. The unit should display “TEST 4” for 1 second.
- B. Transducer test is performed.

If the interface is working correctly, “PASS” will be shown within 15 seconds. Otherwise “FAIL 8” is shown.

If the test fails, do the following:

Check	Failure Mode	Action
Pulses at pins 8 and 10 of IC4	No pulses	Check R68, 76, 77. Check IC4 and IC5 and replace if suspect (trace pulses from IC3).
Pulses at drain of TR5	No pulses	Check L5 and R19 for open circuit. Replace TR5. Replace T1.
Pulses at drain of TR6	No pulses	Check L5 and R19 for open circuit. Replace TR6. Replace T1.
Pulses at DEPTH+ and DEPTH-	No pulses	Check C11 and C12 for open circuit. Replace T1
Depth receiver output pulses at pin 11 of IC5	No pulses	Fault diagnosis of the depth receiver circuit requires specialist knowledge and the units should be returned to Raytheon Marine Ltd.

Press Key 1 and Key 2 together momentarily to exit self-test.

ST60 Depth spare parts list

The **item** numbers refer to

Figure 1: ST60 Digital instrument exploded view

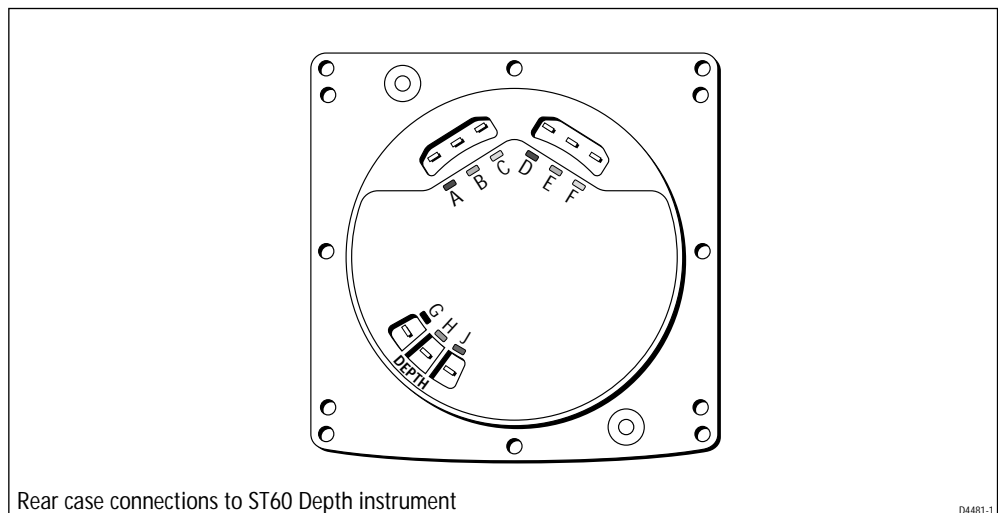
Item	Spare/Accessory Description	Part No.	Comments
1	Facia bezel	A25001	
–	Suncover, standard	A25004	Not illustrated
2	Keypad, Depth	A28019	Pack of 5
	Facia with case seal, <i>including</i>	A28013	
3	Facia		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
	Inner keypad, <i>including</i>	A28022	
4	Inner keypad		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
5	Display label, Depth	A28030	Pack of 5
6	LCD display, Depth	A28023	Also serves the Speed or Multi
	PCB assembly, Depth, <i>including</i>	A28009	Assembled module consisting of items 6, 7, 8, 9.
6	LCD display, Depth		See A28023
7	Diffuser		
8	Reflector		
9	PCB assembly, Depth		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
10	Case seal	A28027	Pack of 5
	Rear case assembly, <i>including</i>	A28014	
10	Case seal		See A28027
11	Rear case		
13	Screw (x8)		
14	Label, Depth (rear case)	A28036	Pack of 5
15	Gasket	A28028	Pack of 5
16	Flush mount bezel	A25002	
	Flush mount kit, <i>including</i>	A25003	
–	Suncover, flush mount		Not illustrated
16	Flush mount bezel		See A25002
17	Screw (x4)		Torque to 0.33Nm (3lb in)
18	Flush mount seal		
19	Rear bracket		

ST60 Depth PCB details

Input/Output signals

(refer to Figure 3. ST60 Depth circuit diagram)

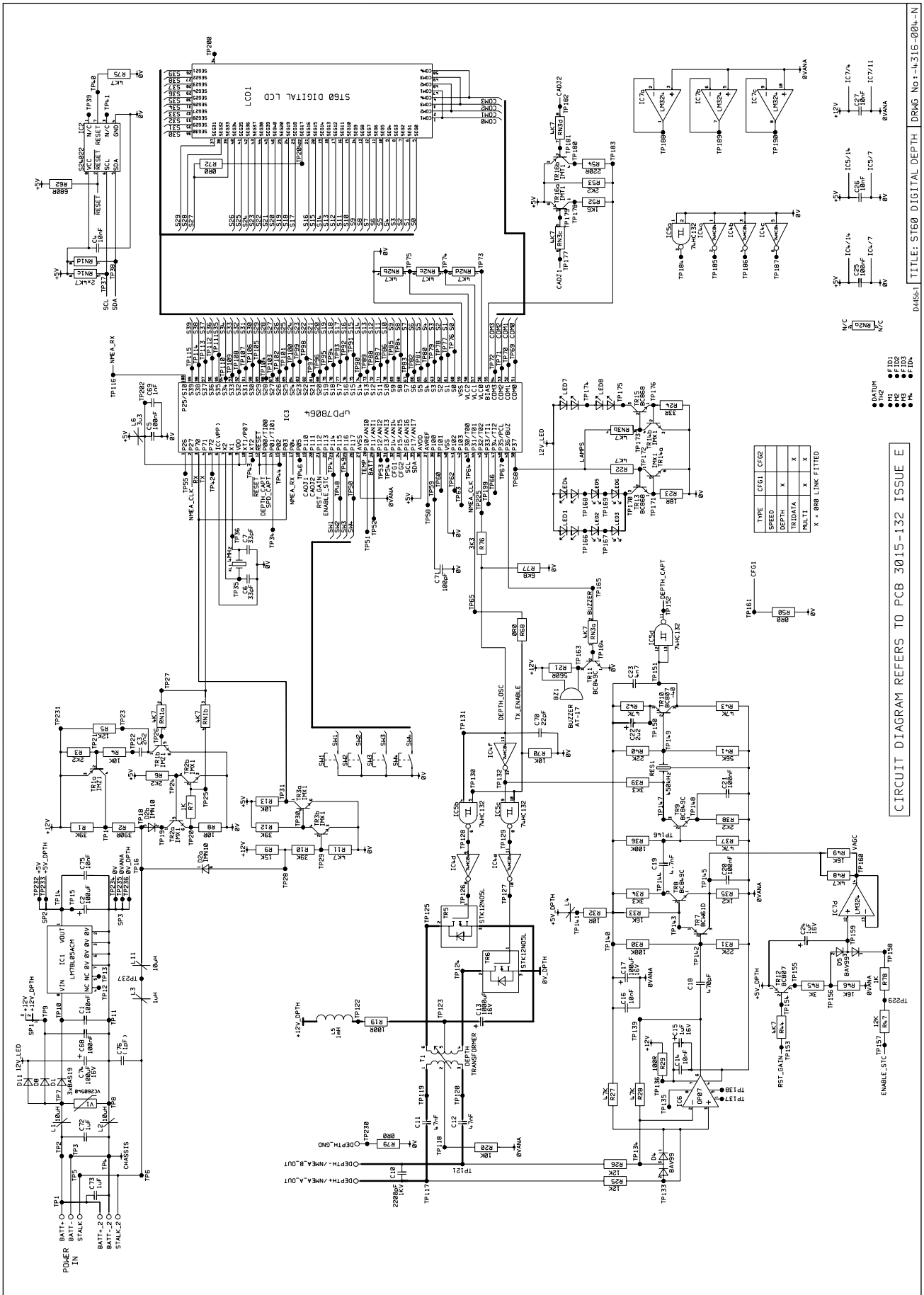
Rear case connection	Signal	Description
A (Red)	BATT+_2	Nominal 12V DC supply
B (Screen)	BATT-_2	OV
C (Yellow)	STALK_2	Intermittent streams of (nominal) 12V pulses
D (Red)	BATT+	Nominal 12V DC supply
E (Screen)	BATT-	OV
F (Yellow)	STALK	Intermittent streams of (nominal) 12V pulses
G (Black)	DEPTH-	Intermittent pulses of 200KHz, approximately 400us wide, 300Vp-p
H (Blue)	DEPTH+	Intermittent pulses of 200KHz, approximately 400us wide, 300Vp-p
J (Screen)	DEPTH_GND	OV



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A22002

ST60 Depth circuit diagram



CIRCUIT DIAGRAM REFERS TO PCB 3015-132 ISSUE E

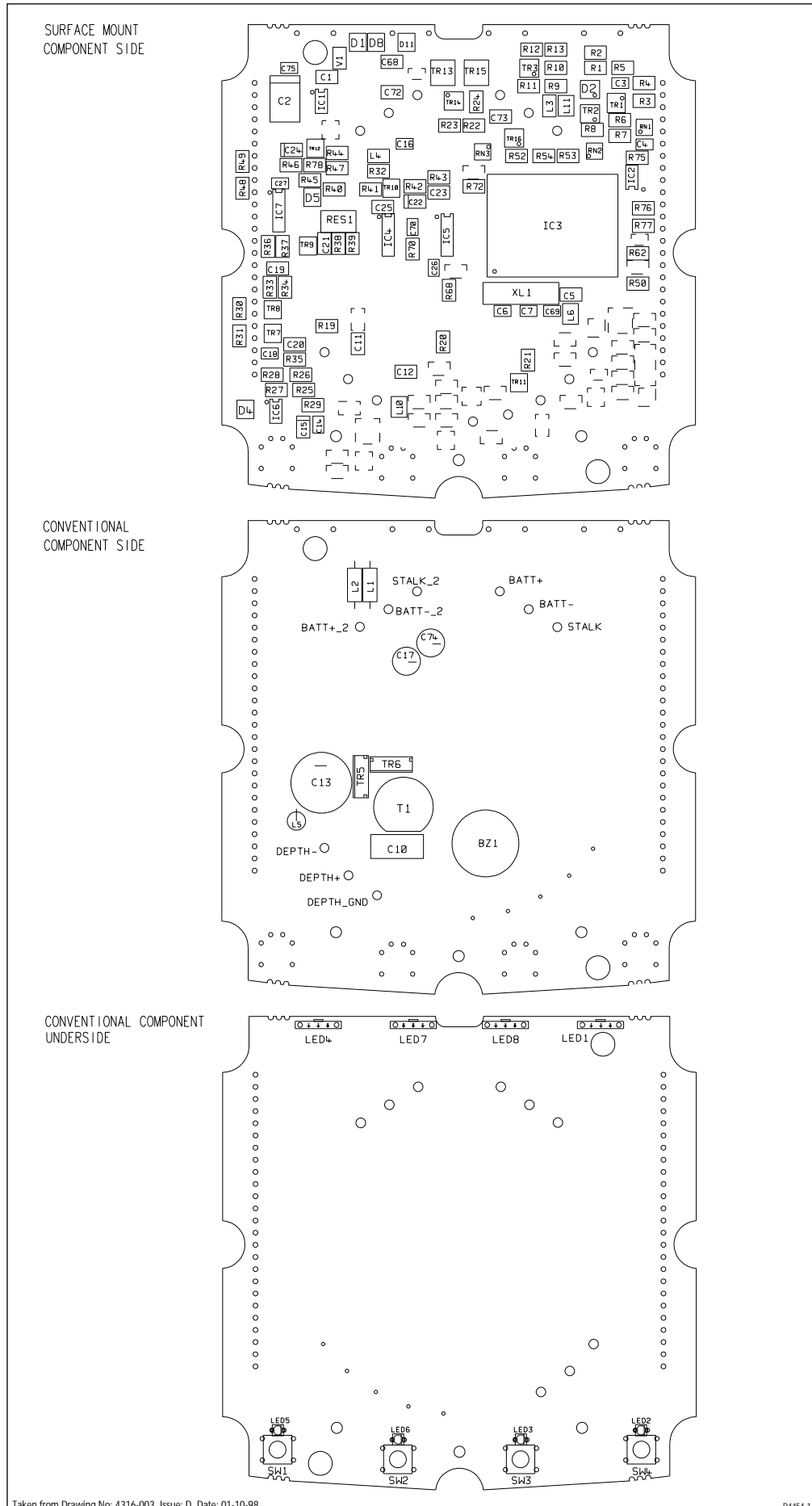
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A22002

Figure 3. ST60 Depth circuit diagram

ST60 Depth PCB layout

A22002



Taken from Drawing No: 4316-003 Issue: D Date: 01-10-98

D4454-1

ST60 Depth PCB component list

SURFACE MOUNT COMPONENT SIDE

9600FILTER1	1	CERAMIC FILTER 450KHz	RES1
96004MHZ	1	CRYSTAL 4MHz	XL1
9600L13	1	CHIP INDUCTOR 3U3 1210	L6
9600L3	1	CHIP INDUCTOR 10uH 1210	L10,11
9600L1	1	SOLID CHIP INDUCTOR	L3,4
9108VC260540	1	VARIABLE VC260540	V1
9400T10P07	1	IC OPAMP OPO7	IC6
940074HC132	1	IC QUAD NAND 74HC132	IC5
940074HC04	1	IC HEX INVERTING BUFFER 74HC04	IC4
940078064	1	IC MICROPROCESSOR uPD78064	IC3
940024022	1	IC EPROM/RESET S24022	IC2
9400LM324	1	IC QUAD OPAMP LM324	IC7
9400LM78L05	1	IC REGULATOR 78L05 5V S08	IC1
95001MT1	1	TRANSISTOR SOT36 DUAL PNP 1MT1	TR16
95001MX1	3	TRANSISTOR SOT36 DUAL NPN 1MX1	TR2,3,14
95001MZ1	1	TRANSISTOR SOT36 DUAL NPN/PNP 1MZ1	TR1
9501BC868	2	TRANSISTOR SOT89 BC868 MULLARD	TR13,15
9500BCW61D	1	TRANSISTOR SOT23 BCW61D	TR7
9500BC849C	3	TRANSISTOR SOT23 BC849C	TR8,9,11
9500BC807	2	TRANSISTOR SOT23 BC807 MULLARD	TR10,12
93261U	2	CAPACITOR COG 1uF 20% 50V 1206	C72,73
930122P	1	CAPACITOR CER 22pF 0805	C70
93060U047	2	CAPACITOR X7R 47nF 50V 1206	C11,12
93BDHXX2N2	1	CAPACITOR X7R 2N2 50V 0805	C3
9301470P	1	CAPACITOR CER 470pF 5% 100V 0805	C18
93064N7	2	CAPACITOR CER 4.7nF 10% 50V 1206	C19,23
93040U01	6	CAPACITOR CER 10nF 10% 50V 0805	C4,14,16,26,27,75
930133P	2	CAPACITOR CER 33pF 0805	C6,7
93041000P	1	CAPACITOR CER 1000pF 10% 50V 0805	C69
93070U1	6	CAPACITOR CER 0.1uF 20% 50V 1206	C1,5,20,21,25,68
9320100U	1	CAPACITOR TANT 100uF 10V TANTE	C2
93102U2	1	CAPACITOR TANT 2u2 20% 6V3 TANTA	C22
93091U	2	CAPACITOR TANT 1uF 10% 16V TANTA	C15,24
92061MN10	1	DIODE TRIPLE ARRAY 1MN10	D2
9200BAV99	2	DIODE BAV99 SOT23	D4,5
9200BAS19	3	DIODE BAS19 SOT23	D1,8,11
91124K7	3	RESISTOR NETWORK 4K7	RN1-3
91033K	1	RESISTOR WCR 1206 3K 1% 0.125W	R45
9106220R	1	RESISTOR WCR 1206 220R 5% 0.125W	R54
9106680R	1	RESISTOR WCR 1206 680R 5% 0.125W	R62
91066K8	1	RESISTOR WCR 1206 6K8 5% 0.125W	R77
9103560R	1	RESISTOR WCR 1206 560R 1% 0.125W	R21
910618R	1	RESISTOR WCR 1206 18R 5% 0.125W	R23
91031K	2	RESISTOR WCR 1206 1K0 1% 0.125W	R7,78
910633R	1	RESISTOR WCR 1206 33R 5% 0.125W	R24
91060R0	3	RESISTOR WCR 1206 0R0 5% 0.125W	R50,68,72
910612K	4	RESISTOR WCR 1206 12K 5% 0.125W	R5,25,26,47
910656K	1	RESISTOR WCR 1206 56K 5% 0.125W	R41
91063K3	3	RESISTOR WCR 1206 3K3 5% 0.125W	R34,39,76
9103100R	2	RESISTOR WCR 1206 100R 1% 0.125W	R19,29
910616K	3	RESISTOR WCR 1206 16K 5% 0.125W	R33,46,49
9106390R	1	RESISTOR WCR 1206 390R 5% 0.125W	R2
910639K	3	RESISTOR WCR 1206 39K 5% 0.125W	R1,10,12
910310R	2	RESISTOR WCR 1206 10R 1% 0.125W	R8,32
91064K7	5	RESISTOR WCR 1206 4K7 5% 0.125W	R11,22,44,48,75
9106100K	2	RESISTOR WCR 1206 100K 5% 0.125W	R30,36
910647K	5	RESISTOR WCR 1206 47K 5% 0.125W	R27,28,37,42,43
91031K6	1	RESISTOR WCR 1206 1K6 1% 0.125W	R52
91031K2	1	RESISTOR WCR 1206 1K2 1% 0.125W	R35
910622K	2	RESISTOR WCR 1206 22K 5% 0.125W	R31,40
91062K2	4	RESISTOR WCR 1206 2K2 5% 0.125W	R3,6,38,53
910615K	1	RESISTOR WCR 1206 15K 5% 0.125W	R9
910610K	4	RESISTOR WCR 1206 10K 5% 0.125W	R4,13,20,70
3015-132	1	PCB ST60 DIGITAL DEPTH	

CONVENTIONAL COMPONENT SIDE

3030-035-C	9	SOLDER BUCKETS	
15341	2	INDUCTOR MINIATURE SC30 10uH 0.25W	L1,2
15219	1	INDUCTOR 1mH	L5
15134	1	TRANSFORMER PULSE	T1
15136	1	BUZZER AT-17	BZ1
15172	2	TRANSISTOR FET STK12N05L T0220	TR5,6
03083	1	CAPACITOR ELEC 2200pF 20% 1KV	C10
03066	1	CAPACITOR ELEC 1000uF 16V	C13
03065	2	CAPACITOR ELEC 100uF +80-20% 16V	C17,74

CONVENTIONAL COMPONENT UNDERSIDE

06030	4	SWITCH ALPMIN TACTILE	SW1-4
15165	4	LED GREEN 2-CHIP	LED1,4,7,8
02050	4	LED GREEN HLMP6505	LED2,3,5,6

Taken from Drawing No: 4316-003 Issue: D Date: 01-10-98

D4455-1

A22002

A22002

Chapter 3. ST60 Multi instrument

Disassembly/reassembly

On reassembly (refer to Figure 1), it is important that the PCB assembly module is fixed to the facia (3) using a torque of 0.22Nm (2lb in). Similarly, fixing the rear case (11) to the facia (3) must also be torqued to 0.22Nm (2lb in).

Note: Failure to practice using the recommended torques may result in damage to the facia inserts. It is also recommended a new case seal (10) is fitted on reassembly.

Self-test procedure

The ST60 Multi instrument has built-in self-test functions to aid fault diagnosis.

To access self-test mode, press Key 1 and Key 4 together for 4 seconds. When the unit beeps, immediately press Key 3 and Key 4 together momentarily. The unit will enter self-test stage 1.

Self test stage 1

- A. The unit should display “TEST 1”
- B. Audible Beep for 1 second.
- C. There will be a seatalk transmission to check the transmit/receive circuits.
- D. The EEPROM is tested.

The following failure codes may be generated:

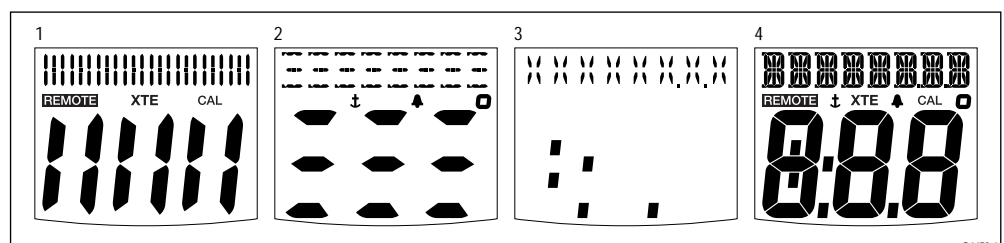
Message	Failure Mode	Action
FAIL 1	Seatalk Rx/Tx	Check for damaged bucket connectors/rear-case pins. Check SeaTalk interface components around TR1, TR2 and TR3.
FAIL 2	EEPROM failure	Replace EEPROM (IC2)

If there is no audible beep, check TR11 and RN3 and the buzzer for damage. If the beep is quiet, check R21.

If all test pass, “PASS” is shown on the display. Press Key 1 and Key 2 together momentarily to progress to self-test stage 2.

Self-test stage 2

- A. The unit should display “TEST 2” for 1 second.
- B. Illumination will change between level 0 and level 3 every second.
- C. Any key press sound cause audible beep.
- D. LCD segments will cycle through the following sequence:



No fail codes are generated since stage 2 is an audio/visual check. The following can, however, be used as a guide to isolate a problem:

Failure Mode	Action
No illumination	Check TR14, TR13, TR15 and associated components. Check all LEDs.
Keypad illumination failure (LCD illumination will also be degraded)	Check TR14, TR13, R22 and R23. Check LED1-6 for open circuit.
Keypad illumination OK but degraded LCD illumination	Check TR14, TR15, RN3, R24. Check LED 7 and 8 for open circuit.
No beep when key pressed	Replace keyswitch.
LCD segment(s) missing completely	Check LCD solder pins for poor/dry joints. Check IC3 for unsoldered pins.
Faint LCD segments	Check LCD pins for shorts. Check IC3 for shorts.

Press Key 1 and Key 2 together momentarily to progress to exit self-test (stages 3 and 4 are not supported on this instrument).

NMEA I/O Testing

Note that there is no self-test for NMEA input/output. As a guideline, if NMEA has failed, do the following:

1. Ensure that NMEA output has been turned ON in user CAL.
2. Ensure that the instrument is receiving seatalk data for translation to NMEA (e.g. Heading, Latitude, Longitude etc...)
3. Voltage at NMEA_OUT+ should be approx 11.2v with 12v battery supply. Current supplied from this pin to BATT- should limit at approx.80mA. If there is a problem with this supply, check TR18, TR19 and associated components.
4. Connect a dummy load (1K resistor) across NMEA_OUT+ and NMEA_OUT- and check for pulses at NMEA_OUT-. If no pulses are seen, check R18 and TR5.
5. Disconnect dummy load and connect NMEA outputs to corresponding NMEA inputs. Check for pulses at the junction of R59 and R60 (TP192). If no pulses are seen, check R55-58, L7 and IC8.
6. Check the final stage output at TR4b (TP116)

ST60 Multi spare parts list

The **item** numbers refer to

Figure 1: ST60 Digital instrument exploded view

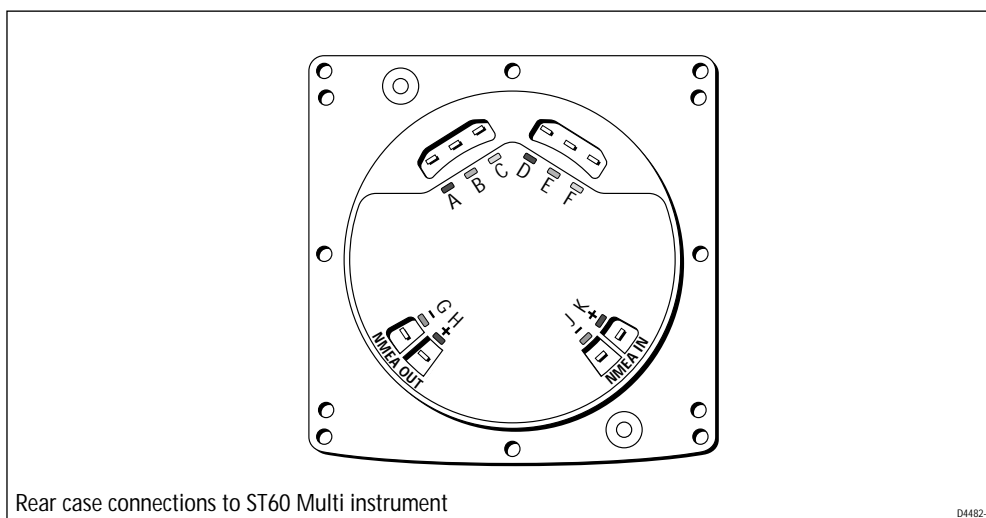
Item	Spare/Accessory Description	Part No.	Comments
1	Facia bezel	A25001	
–	Suncover, standard	A25004	Not illustrated
2	Keypad, Multi	A28021	Pack of 5
	Facia with case seal, <i>including</i>	A28013	
3	Facia		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
	Inner keypad, <i>including</i>	A28022	
4	Inner keypad		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
5	Display label, Multi	A28029	Pack of 5
6	LCD display, Multi	A28023	Also serves the Speed or Depth
	PCB assembly, Multi, <i>including</i>	A28012	Assembled module consisting of items 6, 7, 8, 9. See A28023
6	LCD display, Multi		
7	Diffuser		
8	Reflector		
9	PCB assembly, Multi		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
10	Case seal	A28027	Pack of 5
	Rear case assembly, <i>including</i>	A28014	
10	Case seal		See A28027
11	Rear case		
13	Screw (x8)		Torque to 0.22Nm (2lb in)
14	Label, Multi (rear case)	A28034	Pack of 5
15	Gasket	A28028	Pack of 5
16	Flush mount bezel	A25002	
	Flush mount kit, <i>including</i>	A25003	
–	Suncover, flush mount		Not illustrated
16	Flush mount bezel		See A25002
17	Screw (x4)		Torque to 0.33Nm (3lb in)
18	Flush mount seal		
19	Rear bracket		

ST60 Multi PCB details

Input/Output signals

(refer to Figure 4. ST60 Multi circuit diagram)

Rear case connection	Signal	Description
A (Red)	BATT+_2	Nominal 12V DC supply
B (Screen)	BATT-_2	OV
C (Yellow)	STALK_2	Intermittent streams of (nominal) 12V pulses
D (Red)	BATT+	Nominal 12V DC supply
E (Screen)	BATT-	OV
F (Yellow)	STALK	Intermittent streams of (nominal) 12V pulses
G (Blue)	NMEA_OUT-	Open-drain pull-down
H (Red)	NMEA_OUT+	Approximately 11.2v, current limited to 80mA
J (Blue)	NMEA_IN-	Isolated opto input, 550 ohms
K (Red)	NMEA_IN+	Isolated opto input, 550 ohms



D4482-1

A22003

ST60 Multi circuit diagram

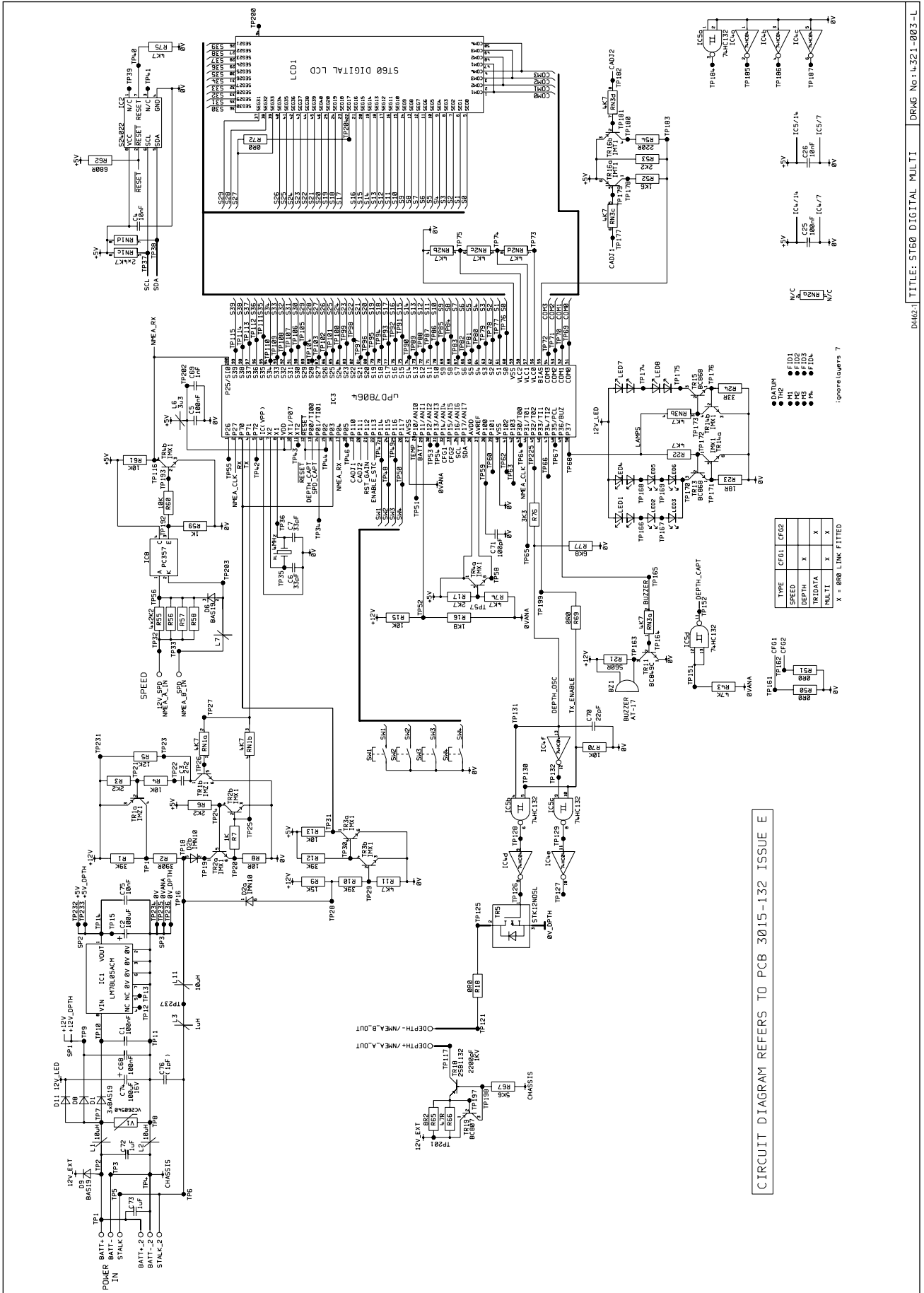
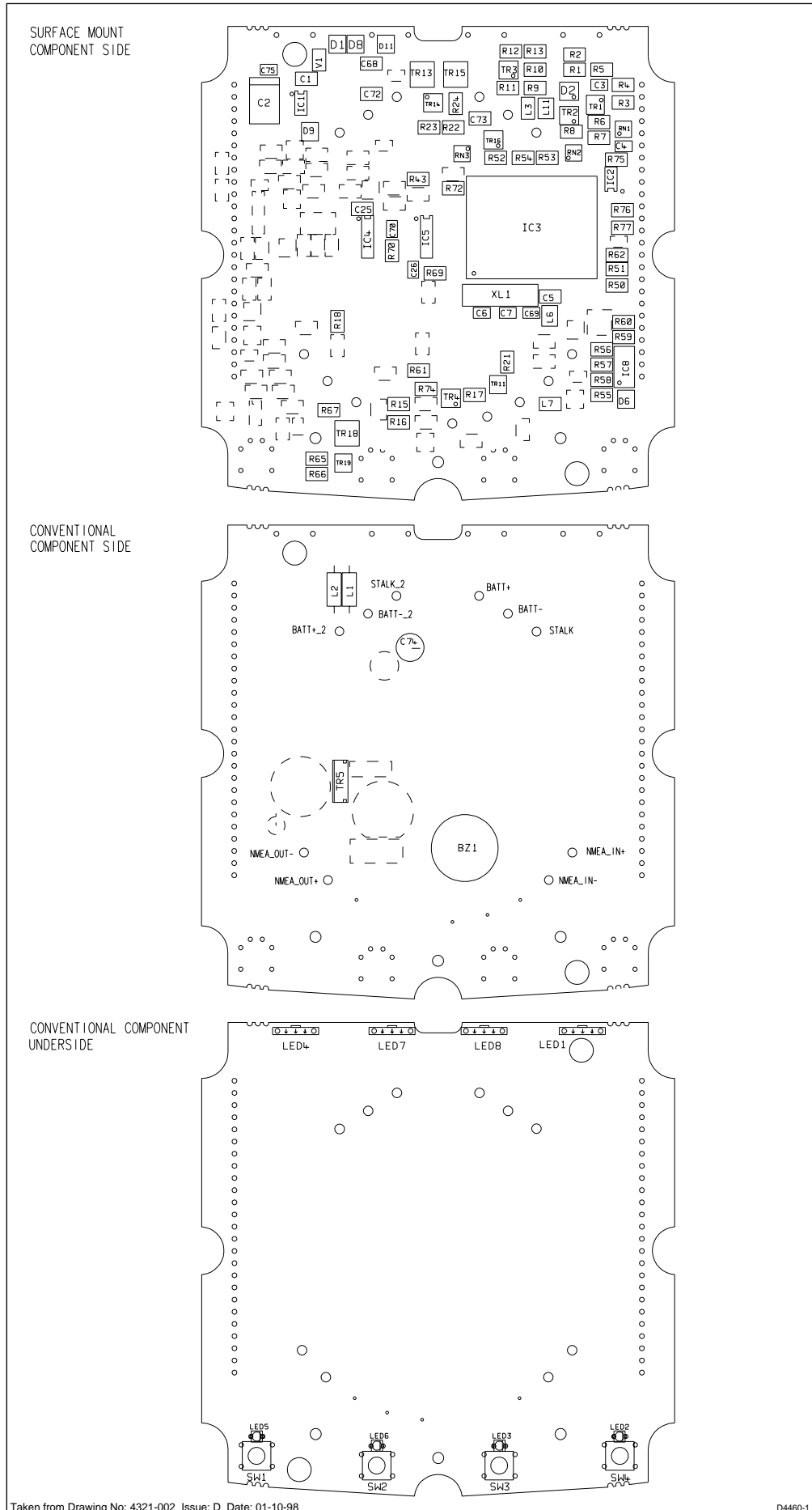


Figure 4. ST60 Multi circuit diagram

ST60 Multi PCB layout

A22003



Taken from Drawing No: 4321-002 Issue: D Date: 01-10-98

D4460-1

ST60 Multi PCB component list

SURFACE MOUNT COMPONENT SIDE

96004MHZ	1	CRYSTAL 4MHz	XL1
9600L13	1	CHIP INDUCTOR 3U3H 1210	L6
9600L3	1	CHIP INDUCTOR 10uH 1210	L11
9600L1	2	SOLID CHIP INDUCTOR	L3,7
9108VC260540	1	VARIABLE CAPACITOR VC260540	V1
9400PC317	1	IC OPTO PC317	IC8
940074HC132	1	IC QUAD NAND 74HC132	IC5
940074HC04	1	IC HEX INVERTING BUFFER 74HC04	IC4
940078064	1	IC MICROPROCESSOR uPD78064	IC3
940024022	1	IC EEPROM/RESET S24022	IC2
9400LM78L05	1	IC REGULATOR 78L05 5V S08	IC1
95002B1132	1	TRANSISTOR SOT89 PNP 2SB1132	TR18
9500IMT1	1	TRANSISTOR SOT36 DUAL PNP IMT1	TR16
9500IMX1	4	TRANSISTOR SOT36 DUAL NPN IMX1	TR2-4,14
9500IMZ1	1	TRANSISTOR SOT36 DUAL NPN/PNP IMZ1	TR1
9501BC868	2	TRANSISTOR SOT89 BC868 MULLARD	TR13,15
9500BC849C	1	TRANSISTOR SOT23 BC849C	TR11
9500BC807	1	TRANSISTOR SOT23 BC807 MULLARD	TR19
93261U	2	CAPACITOR 1uF 20% 50V 1206	C72,73
930122P	1	CAPACITOR COG 22pF 5% 50V 0805	C70
93BDHXX2N2	1	CAPACITOR X7R 2N2 50V 0805	C3
93040U01	3	CAPACITOR CER 10nF 10% 50V 0805	C4,26,75
930133P	2	CAPACITOR CER 33pF 0805	C6,7
93041000P	1	CAPACITOR CER 1000pF 10% 50V 0805	C69
93070U1	4	CAPACITOR CER 0.1uF 20% 50V 1206	C1,5,25,68
9320100U	1	CAPACITOR TANT 100uF 10V TANTE	C2
9206IMN10	1	DIODE TRIPLE ARRAY IMN10	D2
9200BAS19	5	DIODE BAS19 SOT23	D1,6,8,9,11
91124K7	3	RESISTOR NETWORK 4K7	RN1-3
91063K3	1	RESISTOR WCR 1206 3K3 5% 0.125W	R76
9106680R	1	RESISTOR WCR 1206 680R 5% 0.125W	R62
9106220R	1	RESISTOR WCR 1206 220R 5% 0.125W	R54
910618R	1	RESISTOR WCR 1206 18R 5% 0.125W	R23
91061K8	1	RESISTOR WCR 1206 1K8 5% 0.125W	R16
91066K8	1	RESISTOR WCR 1206 6K8 5% 0.125W	R77
9103560R	1	RESISTOR WCR 1206 560R 1% 0.125W	R21
91035K6	1	RESISTOR WCR 1206 5K6 1% 0.125W	R67
91031K	2	RESISTOR WCR 1206 1K0 1% 0.125W	R7,59
910633R	1	RESISTOR WCR 1206 33R 5% 0.125W	R24
91068R2	1	RESISTOR WCR 1206 8R2 5% 0.125W	R65
910647R	1	RESISTOR WCR 1206 47R 5% 0.125W	R66
91060R0	5	RESISTOR WCR 1206 0R0 5% 0.125W	R18,50,51,69,72
91062K7	1	RESISTOR WCR 1206 2K7 5% 0.125W	R17
910612K	1	RESISTOR WCR 1206 12K 5% 0.125W	R5
9106390R	1	RESISTOR WCR 1206 390R 5% 0.125W	R2
910639K	3	RESISTOR WCR 1206 39K 5% 0.125W	R1,10,12
910310R	1	RESISTOR WCR 1206 10R 1% 0.125W	R8
91064K7	4	RESISTOR WCR 1206 4K7 5% 0.125W	R11,22,74,75
910647K	1	RESISTOR WCR 1206 47K 5% 0.125W	R43
91031K6	1	RESISTOR WCR 1206 1K6 1% 0.125W	R52
91062K2	7	RESISTOR WCR 1206 2K2 5% 0.125W	R3,6,53,55-58
910615K	1	RESISTOR WCR 1206 15K 5% 0.125W	R9
910610K	6	RESISTOR WCR 1206 10K 5% 0.125W	R4,13,15,60,61,70
3015-132	1	PCB ST60 DIGITAL MULTI	

CONVENTIONAL COMPONENT SIDE

3030-035-C	10	SOLDER BUCKETS	
15136	1	BUZZER AT-17	BZ1
15172	1	TRANSISTOR FET STK12N05L T0220	TR5
15341	2	INDUCTOR MINIATURE SC30 10uH 0.25W	L1,2
03065	1	CAPACITOR ELEC 100uF +80-20% 16V	C74

CONVENTIONAL COMPONENT UNDERSIDE

06030	4	SWITCH ALPMIN TACTILE	SW1-4
15165	4	LED GREEN 2-CHIP	LED1,4,7,8
02050	4	LED GREEN HLMP6505	LED2,3,5,6

Taken from Drawing No: 4321-002 Issue: D Date: 01-10-98

D4461-1

A22003

A22003

Chapter 4. ST60 Tridata instrument

Disassembly/reassembly

On reassembly (refer to Figure 1), it is important that the PCB assembly module is fixed to the facia (3) using a torque of 0.22Nm (2lb in). Similarly, fixing the rear case (11) to the facia (3) must also be torqued to 0.22Nm (2lb in).

Note: Failure to practice using the recommended torques may result in damage to the facia inserts. It is also recommended a new case seal (10) is fitted on reassembly.

Self-test procedure

The ST60 Tridata instrument has built-in self-test functions to aid fault diagnosis.

To access self-test mode, press Key 1 and Key 4 together for 4 seconds. When the unit beeps, immediately press Key 3 and Key 4 together momentarily. The unit will enter self-test stage 1.

Self test stage 1

- The unit should display “TEST 1”
- Audible Beep for 1 second.
- There will be a SeaTalk transmission to check the transmit/receive circuits.
- The EEPROM is tested.

The following failure codes may be generated:

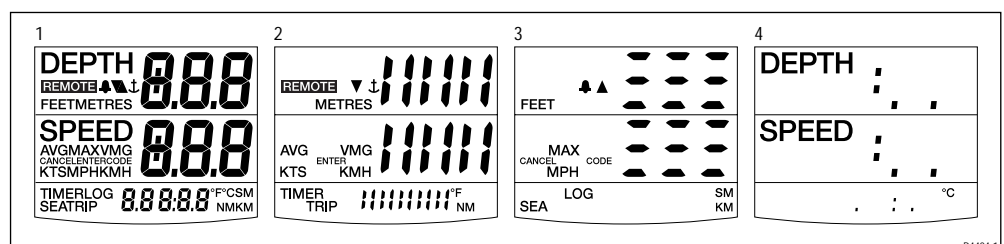
Message	Failure Mode	Action
FAIL 1	SeaTalk Rx/Tx	Check for damaged bucket connectors/rear-case pins. Check SeaTalk interface components around TR1, TR2 and TR3.
FAIL 2	EEPROM failure	Replace EEPROM (IC2)

If there is no audible beep, check TR11 and RN3 and the buzzer for damage. If the beep is quiet, check R21.

If all test pass, “PASS” is shown on the display. Press Key 1 and Key 2 together momentarily to progress to self-test stage 2.

Self-test stage 2

- The unit should display “TEST 2” for 1 second.
- Illumination will change between level 0 and level 3 every second.
- Any key press sound cause audible beep.
- LCD segments will cycle through the following sequence:



No fail codes are generated since stage 2 is an audio/visual check. The following can, however, be used as a guide to isolate a problem:

Failure Mode	Action
No illumination	Check TR14, TR13, TR15 and associated components. Check all LEDs.
Keypad illumination failure (LCD illumination will also be degraded).	Check TR14, TR13, R22 and R23. Check LED1-6 for open circuit.
Keypad illumination OK but degraded LCD illumination.	Check TR14, TR15, RN3, R24. Check LED 7 and 8 for open circuit.
No beep when key pressed.	Replace keyswitch.
LCD segment(s) missing completely.	Check LCD solder pins for poor/dry joints. Check IC3 for unsoldered pins.
Faint LCD segments	Check LCD pins for shorts. Check IC3 for shorts.

Press Key 1 and Key 2 together momentarily to progress to self-test stage 4 (stage 3 not supported on this instrument).

Self-test stage 4

Note: A known good speed and depth transducer must be connected for this test.

A. The unit should display ‘TEST 4’ for 1 second.

B. Transducer tests are performed.

Spin the paddle wheel within 15 seconds of entering this test. If there is a problem with the speed interface “FAIL 10” is shown and the following tests should be carried out.

Check	Failure Mode	Action
Voltage at 12V_SPD	No voltage or low voltage (<11.0) with 12V battery supply.	Check TR17, TR20, R63 and R64.
L7	Open circuit	Replace L7.
D3	Open circuit	Replace D3.
Voltage at TEMP pin	Outside acceptable range of 0.76 to 1.00V (18 - 25 degrees C)	Check L9 for open circuit. Check R14.
AVREF	Outside acceptable range of 2.5V +/- 0.25v	Check TR4. Check R74, 17.

Provided the depth transducer is in water where a good echo should be seen, the test will pass, otherwise “FAIL 8” is shown and the following tests should be carried out:

Check	Failure Mode	Action
Pulses at pins 8 and 10 of IC4	No pulses	Check R68, 76, 77. Check IC4 and IC5 and replace if suspect (trace pulses from IC3).
Pulses at drain of TR5	No pulses	Check L5 and R19 for open circuit. Replace TR5. Replace T1.
Pulses at drain of TR6	No pulses	Check L5 and R19 for open circuit. Replace TR6. Replace T1.
Pulses at DEPTH+ and DEPTH-	No pulses	Check C11 and C12 for open circuit. Replace T1
Depth receiver output pulses at pin 11 of IC5	No pulses	Fault diagnosis of the depth receiver circuit requires specialist knowledge and the units should be returned to Raytheon Marine Ltd.

Press Key 1 and Key 2 together momentarily to exit self-test.

ST60 Tridata spare parts list

The **item** numbers refer to

Figure 1: ST60 Digital Instrument exploded view

Item	Spare/Accessory Description	Part No.	Comments
1	Facia bezel	A25001	
–	Suncover, standard	A25004	Not illustrated
2	Keypad, Tridata	A28020	Pack of 5
	Facia with case seal, <i>including</i>	A28013	
3	Facia		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
	Inner keypad, <i>including</i>	A28022	
4	Inner keypad		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
5	Display label, Tridata	A28032	Pack of 5
6	LCD display, Tridata	A28024	
	PCB assembly, Tridata, <i>including</i>	A28011	Assembled module consisting of items 6, 7, 8, 9. See A28024
6	LCD display, Tridata		
7	Diffuser		
8	Reflector		
9	PCB assembly, Tridata		
10	Case seal		See A28027
12	Washer (x3)		
13	Screw (x11)		Torque to 0.22Nm (2lb in)
10	Case seal	A28027	Pack of 5
	Rear case assembly, <i>including</i>	A28014	
10	Case seal		See A28027
11	Rear case		
13	Screw (x8)		Torque to 0.22Nm (2lb in)
14	Label, Tridata (rear case)	A28033	Pack of 5
15	Gasket	A28028	Pack of 5
16	Flush mount bezel	A25002	
	Flush mount kit, <i>including</i>	A25003	
–	Suncover, flush mount		Not illustrated
16	Flush mount bezel		See A25002
17	Screw (x4)		Torque to 0.33Nm (3lb in)
18	Flush mount seal		
19	Rear bracket		

A22004

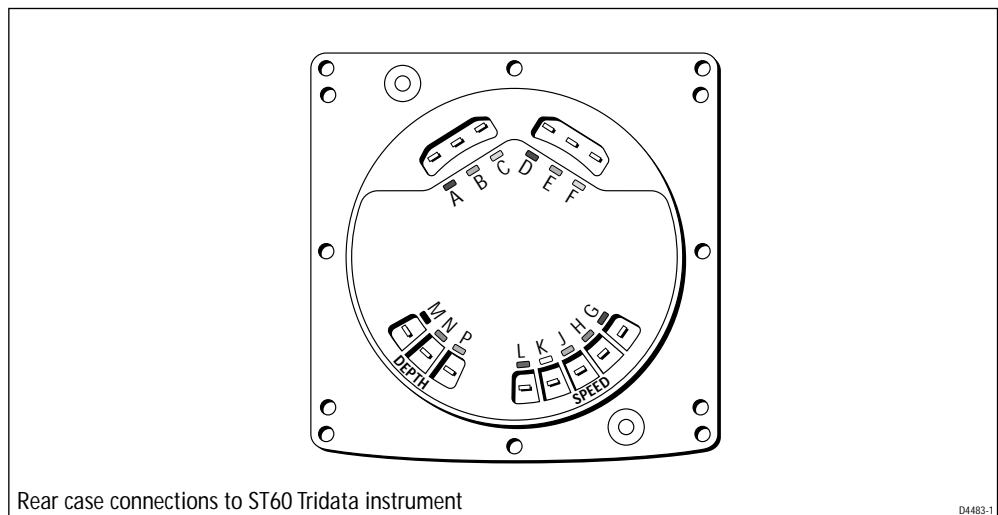
ST60 Tridata PCB details

Input/Output signals

(refer to Figure 5. ST60 Tridata circuit diagram)

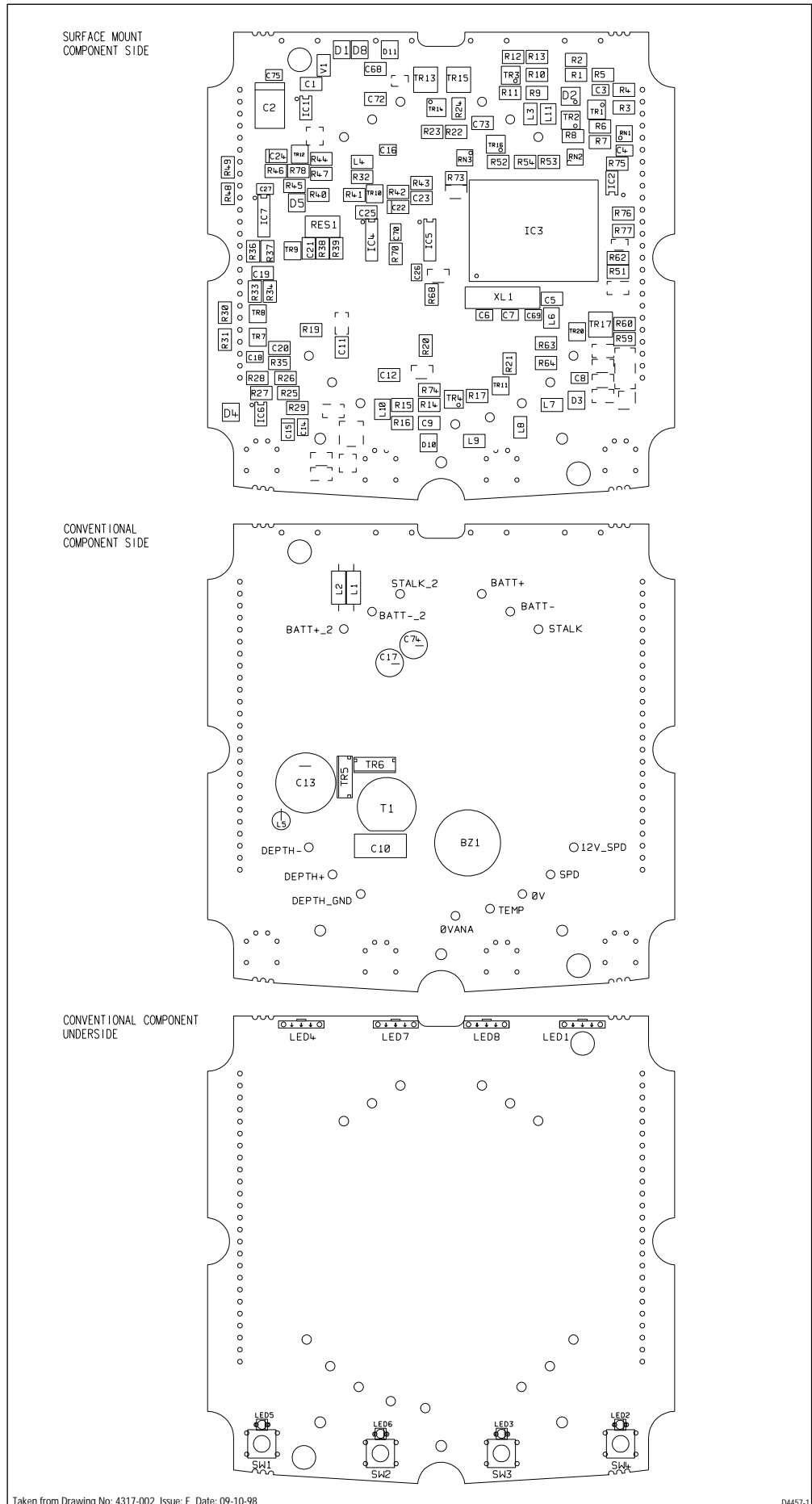
Rear case connection	Signal	Description
A (Red)	BATT+_2	Nominal 12V DC supply
B (Screen)	BATT-_2	OV
C (Yellow)	STALK_2	Intermittent streams of (nominal) 12V pulses
D (Red)	BATT+	Nominal 12V DC supply
E (Screen)	BATT-	OV
F (Yellow)	STALK	Intermittent streams of (nominal) 12V pulses
G (Red)	12V_SPD	Approximately 11.2V DC out
H (Green)	SPD	With transducer attached, spinning paddle-wheel produces pulses approximately 11.2V DC in amplitude at 5.5Hz/Knot.
J (Screen)	OV	OV
K (White)	TEMP	With transducer attached, voltage here is dependant on temperature. Approximately 1.8v at 0 degrees C.
L (Brown)	OVANA	OV
M (Black)	DEPTH-	Intermittent pulses of 200KHz, approximately 400us wide, 300Vp-p
N (Blue)	DEPTH+	Intermittent pulses of 200KHz, approximately 400us wide, 300Vp-p
P (Screen)	DEPTH_GND	OV

A22004



ST60 Tridata PCB layout

A22004



Taken from Drawing No: 4317-002 Issue: E Date: 09-10-98

ST60 Tridata PCB component list

CONVENTIONAL COMPONENT UNDERSIDE

06030	4	SWITCH ALPMIN TACTILE	SWI-4
15165	4	LED GREEN 2-CHIP	LED1,4,7,8
02050	4	LED GREEN HLM6505	LED2,3,5,6

CONVENTIONAL COMPONENT SIDE

3030-035-C	14	SOLDER BUCKETS	
15341	2	INDUCTOR MINIATURE SC30 10uH 0.25W	L1,2
15219	1	INDUCTOR 1mH	L5
15134	1	TRANSFORMER PULSE	T1
15136	1	BUZZER AT-17	BZ1
15172	2	TRANSISTOR FET STK12N05L TO220	TR5,6
03083	1	CAPACITOR CER 2200pF 20% 1KV	C10
03066	1	CAPACITOR ELEC 1000uF 16V	C13
03065	2	CAPACITOR ELEC 100uF +80-20% 16V	C17,74

SURFACE MOUNT COMPONENT SIDE

9600FILTER1	1	CERAMIC FILTER 450KHz	RES1
96004MHZ	1	CRYSTAL 4MHz	XL1
9600L13	2	CHIP INDUCTOR 3U3H 1210	L6,10
9600L3	1	CHIP INDUCTOR 10uH 1210	L11
9600L1	5	SOLID CHIP INDUCTOR	L3,4,7-9
9108VC260540	1	VARIABLE VC260540	V1
9400T1OP07	1	IC OPAMP OP07	IC6
940074HC132	1	IC QUAD NAND 74HC132	IC5
940074HC04	1	IC HEX INVERTING BUFFER 74HC04	IC4
940078064	1	IC MICROPROCESSOR uPD78064	IC3
940024022	1	IC EEPROM/RESET S24022	IC2
9400LM324	1	IC QUAD OPAMP LM324	IC7
9400LM78L05	1	IC REGULATOR 78L05 5V S08	IC1
95002B1132	1	TRANSISTOR SOT89 PNP 2SB1132	TR17
95001MT1	1	TRANSISTOR SOT36 DUAL PNP 1MT1	TR16
95001MX1	4	TRANSISTOR SOT36 DUAL NPN 1MX1	TR2-4,14
95001MZ1	1	TRANSISTOR SOT36 DUAL NPN/PNP 1MZ1	TR1
9501BC868	2	TRANSISTOR SOT89 BC868 MULLARD	TR13,15
9500BCW61D	1	TRANSISTOR SOT23 BCW61D	TR7
9500BC849C	3	TRANSISTOR SOT23 BC849C	TR8,9,11
9500BC807	3	TRANSISTOR SOT23 BC807 MULLARD	TR10,12,20
93261U	2	CAPACITOR 1uF 20% 50V 1206	C72,73
930122P	1	CAPACITOR COG 22pF 5% 50V 0805	C70
93060U047	2	CAPACITOR X7R 47nF 50V 1206	C11,12
93BDHXX2N2	1	CAPACITOR X7R 2N2 50V 0805	C3
9301470P	1	CAPACITOR CER 470pF 5% 100V 0805	C18
93064N7	2	CAPACITOR CER 4.7nF 10% 50V 1206	C19,23
93040U01	7	CAPACITOR CER 10nF 10% 50V 0805	C4,8,14,16,26,27,75
930133P	2	CAPACITOR CER 33pF 0805	C6,7
93041000P	1	CAPACITOR CER 1000pF 10% 50V 0805	C69
93070U1	7	CAPACITOR CER 0.1uF 20% 50V 1206	C1,5,9,20,21,25,68
9320100U	1	CAPACITOR TANT 100uF 10V TANTA	C2
93102U2	1	CAPACITOR TANT 2u2 20% 6V3 TANTA	C22
93091U	2	CAPACITOR TANT 1uF 10% 16V TANTA	C15,24
9203BZ84C5V1	1	DIODE ZENER 5V1 SOT23	D10
92061MN10	1	DIODE TRIPLE ARRAY 1MN10	D2
9200BAV99	2	DIODE BAV99 SOT23	D4,5
9200BAS19	4	DIODE BAS19 SOT23	D1,3,8,11
91124K7	3	RESISTOR NETWORK 4K7	RNI-3
91033K	1	RESISTOR WCR 1206 3K 1% 0.125W	R45
91061K8	1	RESISTOR WCR 1206 1K8 5% 0.125W	R16
910618R	1	RESISTOR WCR 1206 18R 5% 0.125W	R23
9106680R	1	RESISTOR WCR 1206 680R 5% 0.125W	R62
91066K8	1	RESISTOR WCR 1206 6K8 5% 0.125W	R77
9103560R	1	RESISTOR WCR 1206 560R 1% 0.125W	R21
9106220R	1	RESISTOR WCR 1206 220R 5% 0.125W	R54
910622R	1	RESISTOR WCR 1206 22R 5% 0.125W	R63
91031K	3	RESISTOR WCR 1206 1K0 1% 0.125W	R7,59,78
910633R	2	RESISTOR WCR 1206 33R 5% 0.125W	R24
91060R0	3	RESISTOR WCR 1206 0R0 5% 0.125W	R51,68,73
91062K7	1	RESISTOR WCR 1206 2K7 5% 0.125W	R17
910656K	2	RESISTOR WCR 1206 56K 5% 0.125W	R14,41
91063K3	3	RESISTOR WCR 1206 3K3 5% 0.125W	R34,39,76
9103100R	2	RESISTOR WCR 1206 100R 1% 0.125W	R19,29
910616K	4	RESISTOR WCR 1206 16K 5% 0.125W	R33,46,49,64
910612K	4	RESISTOR WCR 1206 12K 5% 0.125W	R5,25,26,47
9106390R	1	RESISTOR WCR 1206 390R 5% 0.125W	R2
910639K	3	RESISTOR WCR 1206 39K 5% 0.125W	R1,10,12
910310R	2	RESISTOR WCR 1206 10R 1% 0.125W	R8,32
91064K7	6	RESISTOR WCR 1206 4K7 5% 0.125W	R11,22,44,48,74,75
9106100K	2	RESISTOR WCR 1206 100K 5% 0.125W	R30,36
910647K	5	RESISTOR WCR 1206 47K 5% 0.125W	R27,28,37,42,43
91031K6	1	RESISTOR WCR 1206 1K6 1% 0.125W	R52
91031K2	1	RESISTOR WCR 1206 1K2 1% 0.125W	R35
910622K	2	RESISTOR WCR 1206 22K 5% 0.125W	R31,40
91062K2	4	RESISTOR WCR 1206 2K2 5% 0.125W	R3,6,38,53
910615K	1	RESISTOR WCR 1206 15K 5% 0.125W	R9
910610K	6	RESISTOR WCR 1206 10K 5% 0.125W	R4,13,15,20,60,70
3015-132	1	PCB ST60 DIGITAL TRIDATA	

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