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Part 2 – Technical Sections

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Section TM2: Failure Alarms and Messages.

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Section TM5: The Diagnostic Utility.

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Section TM1: Basic System.

TM1.1: The Heading Sensor Coil (HSC2).

TM1.2: NT888G Distribution Unit.

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The basic Autopilot system is shown in Fig 1.0 with terminal block services detailed in Fig 2.1.2 of the Installation section (Part 1) of the manual.

The Autopilot receives heading information from either a sensor coil (HSC2) mounted above or below a Magnetic compass or via 2 x NMEA0183 serial data input ports fed from Gyro compass, GPS compass or other proprietary heading sensor. Which sensor is in use is initially selected by the HSC2/NMEA Ch.A and Ch.B priorities selected in the Autopilot Set Up Menu. (Installation Set Up parameters 3.32 and 3.33).

Rate of Turn (ROT) data can also be received on the 2 x NMEA 0183 input ports which accept the $xxROT sentence. If external ROT data is available, it will be used in preference to the Autopilot internally calculated value.

Heading to Steer data can also be received from an approved Track Control System when the Autopilot is “ON” and the track mode is in operation via “TRACK” key selection.

The rudder position is fed back to the Autopilot via a conductive plastic potentiometer mounted within the Rudder Reference Unit (RRU). The RRU also houses the limit switches which, when correctly set, prevent the Autopilot driving the rudder to its mechanical extremes.

The Autopilot requires a supply voltage between 11 and 40Vdc for the control electronics, and can accept a wider range of supply (11 to 110Vdc) for the solenoid drives to the hydraulic steering system. The solenoid outputs are rated 5 Amps maximum and can be configured for common –ve (positive switchlines) or common +ve (negative switchline) operation.

The NT888G Autopilot system also provides alternative steering control signals from the Distribution Unit via dual +/-10Vdc and dual 4-20mA analogue outputs.

Dependent upon external steering device availability and Autopilot external Changeover switching configurations, the NT888G can provide dual solenoid set switching with common or independent power supplies, Rudder only, Thruster only or Rudder and Thruster control modes.

TM1.1: Heading Sensor Coil (HSC2)

The Heading Sensor Coil is an active device comprising 3 sense coils in a star formation interacting with an excitation winding which is driven at 400Hz from the Autopilot Distribution Unit. The coil configuration and associated amplifiers are P.C.Board mounted in an encapsulated assembly, which also receives a +7V regulated supply from the Distribution Unit. When excited at 400Hz, the resultant 3 phase 'spike' waveforms returned from the star windings to the DB vary in phase and amplitude depending on the position of the coils relative to the massive magnets contained within the proprietary Magnetic compass.

Variations in amplitude as a function of vessel-to-vessel variations in magnetic compass field strength are automatically compensated for within the Autopilot via automatic gain control (AGC) thus no adjustment is normally required.

Possible failure messages associated with the HSC2 are: -
CPS LO FAIL - Compass signal strength less that 200 (see section TM2.2.2)
CPS HI FAIL - Compass signal strength greater than 4096 (see section TM2.2.1)
CPS PHS FAIL Compass phases are not consistent (see section TM2.2.3)

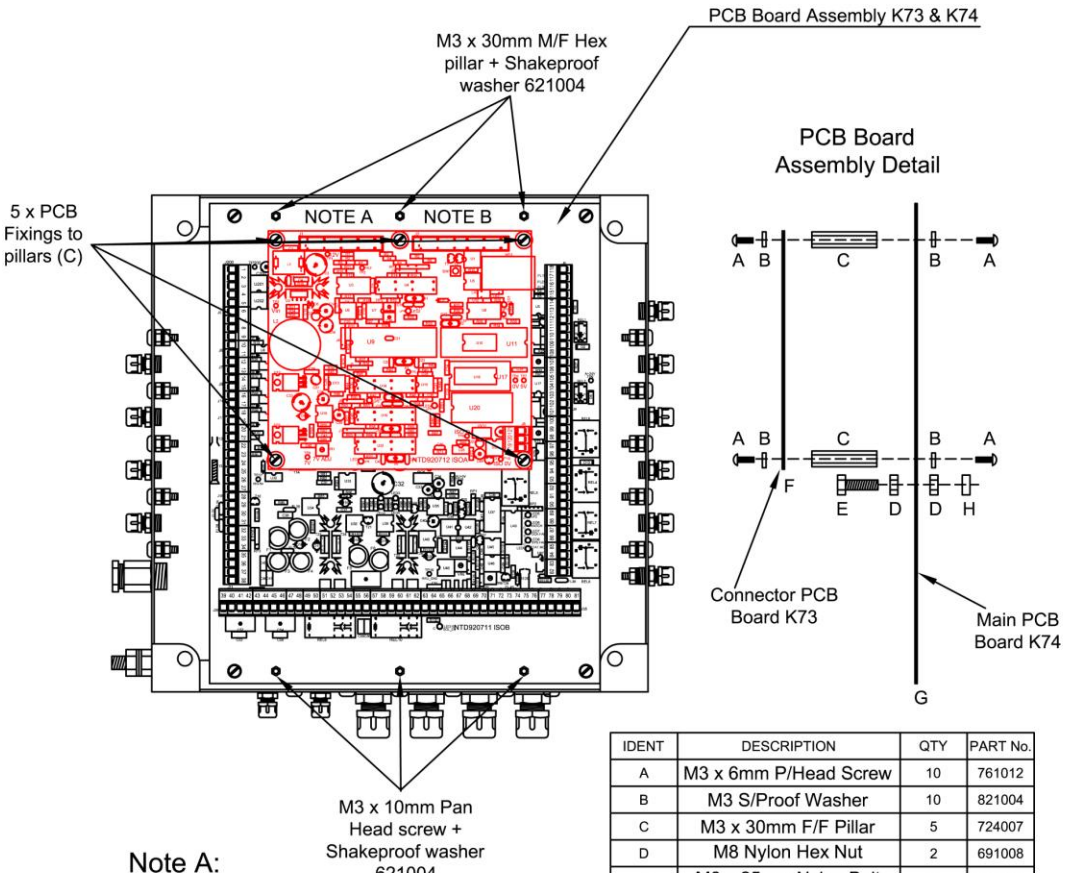
TM1.2: NT888G Distribution Unit.

The NT888G Distribution Unit is the central distribution point for the Autopilot system and contains all system fuses (electronics @ 2A, solenoids @ 5A). All power supply, heading input, speed and track data input, solenoid/analogue output and NMEA data output cables are routed to and connected within the Distribution Unit in accordance with Installation Section FIGs 2 and 2.1.2.

The Distribution Unit contains 2 PCBs known as the Main (6 x processors) and Connector (121 terminal ways) with schematic and component layout details shown in section TM6.

Main and Connector PCB stack arrangement and Distribution Unit General Assembly details are shown in FIG TM1.2.

Power distribution details internal to the NT888G DB and to external services are dealt with in section TM4.



IDENT	DESCRIPTION	QTY	PART No.
A	M3 x 6mm P/Head Screw	10	761012
B	M3 S/Proof Washer	10	821004
C	M3 x 30mm F/F Pillar	5	724007
D	M8 Nylon Hex Nut	2	691008
E	M8 x 25mm Nylon Bolt	1	761054
F	Main PCB K74	1	-
G	Connector PCB K73	1	-
H	Adhesive gasket	10mm	-

Note A:
Attach 34 way ribbon cable between K73 & K74 connectors

Note B
Attach 40 way ribbon cable between K73 & K74 connectors

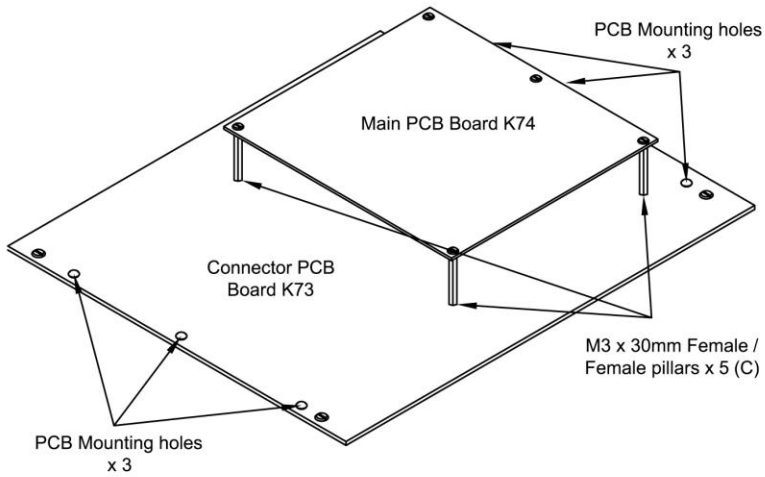


FIG TM1.2 – NT888G Distribution Unit Assembly Details

TM1.3: NMEA 0183 Heading Data.

The NT888G will accept NMEA heading & ROT data on two independent isolated inputs that comply with the NMEA 0183 standard for interfacing marine electronics devices Version 3.00 July 1st , 2000 and IEC 61162/1 & /2 protocols.

Briefly the specification is: -Data transmitted in serial asynchronous form in accordance with ANSI standards with the following parameters:

Baud Rate 4800
Data Bits 8 (d7=0)
Parity None
Stop Bits 1
Least significant bit first.
Logic Levels are:- 1 is in the range –15V to +0.5V
0 is in the range +2V to +15V

The NMEA 0183 signal lines are designated A & B and it should be noted that when using the preferred EIA-422 5V differential driver, both lines are driven and therefore neither line can be considered as 'ground'. The logic 1 level (or 'idle') is defined as a negative voltage on line A with respect to line B and conversely the logic 0 level (or 'active') is defined as a positive voltage on line A with respect to line B.

NMEA 0183 Heading Data Input Sentences.

Preferred NMEA 0183 receiver is an opto isolator or EIA-422 differential device and the structure of transmitted data must strictly follow the NMEA specification:-

$XXHDT,nnn.n,T*hh(CR)(LF)
$XXHDM,nnn.n,M*hh(CR)(LF)
$XXHCC,nnn.n*hh(CR)(LF)
$XXHDG,nnn.n,d.d,E,v.v,E*hh(CR)(LF)

Where: $ = start of sentence
XX = talker identifier (don't care)
nnn.n = floating point heading data
*hh = optional hexadecimal checksum
d.d = floating point deviation data
E = east (E) or west (W)
v.v = floating point variation data

NMEA 0183 Rate of Turn Sentence $xxROT,nn.n,A*hh(CR)(LF).

Where $,xx,*hh are as defined above and nn.n = ROT in deg/min and a minus sign "-" = bow turning to Port.

The Autopilot is internally equipped with an opto isolated input that conforms to the NMEA standard and various facilities are provided within the diagnostic utility to aid fault finding of the NMEA 0183 serial interfaces as detailed in section TM5.0. (See also installation section 2.3).

TM1.3: NMEA 0183 Heading Data (Continued).

NMEA 0183 Heading Output Data.

A total of 6 sentence types are transmitted at installation selectable 4800 or 38K4 baud rates dependent upon Set Up Menu (installation sections 3.32 & 3.45) and as described in installation sections 2.15 & 2.16.

These outputs are shared by 2 isolated outputs (Chan. 1 & Chan. 2).
Chan. 1 Heading Output Sentences:-

Output terminals 98 (B), 99 (A), 100 (GND) of 888G Distribution Unit:-

$XXTHS,X.X,a*hh<CR><LF>
$XXHDT,nnn.n,T*hh(CR)LF
$XXHDM,nnn.n,M*hh(CR)LF
$XXHDG,nnn.n,d.d,E(or)W,,*hh(CR)LF

Where: $ = start of sentence
XX = talker identifier (don't care)
nnn.n = floating point heading data
*hh = checksum
d.d = floating point deviation data
E = East (E) or West (W)
v.v = floating point variation data

NMEA 0183 Autopilot Track & Status Output Data.

Chan. 1 Rudder Status Output:-
Output terminals 98 (B), 99 (A), 100 (GND) of 888G Distribution Unit:-

$XXRSA, x.x, A, ,,, V*hh<CR><LF>

Where: $ = start of sentence
XX = talker identifer (don`t care)
x.x, = Rudder sensor, degrees
"A" = Rudder status valid
"V" = Data invalid

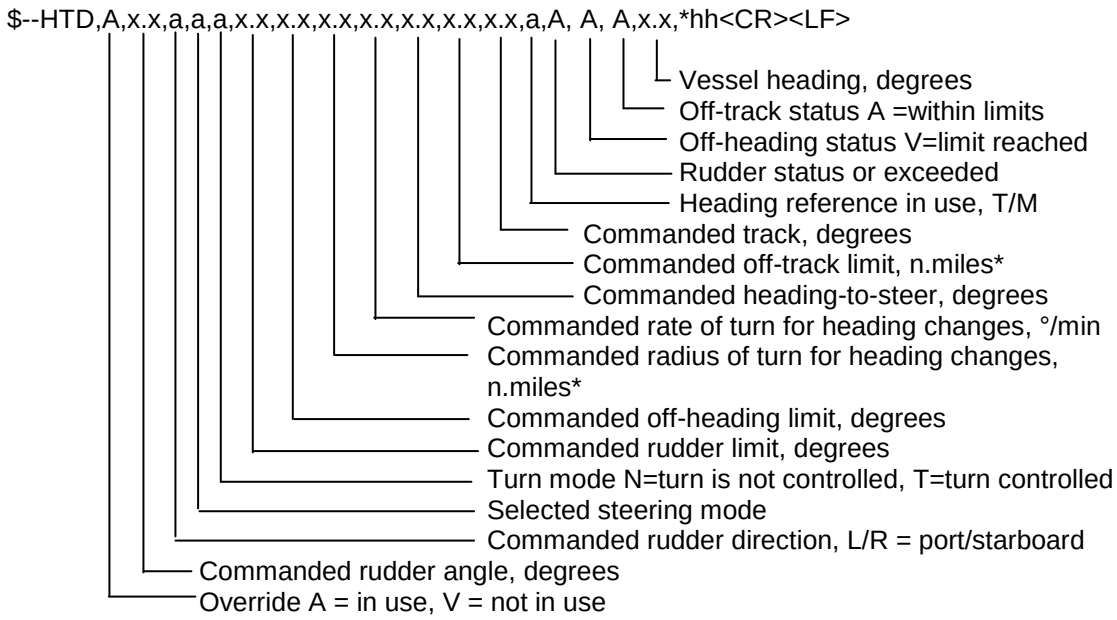
The $XXRSA sentence is always transmitted (1Hz) but in the event of rudder reference failure ("rru FAIL" message on the display), 3.5V or 2.5V reference failure the sensor status flag will be set to invalid "V" and the sensor angle field will be a null field. The sensor angle field is in degrees, "-" = bow turns to PORT.

Chan. 1 Track Data Output:-
Output terminals 98 (B), 99 (A), 100 (GND) of 888G Distribution Unit:-

$XXHTD,A,x.x,a,a,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,A, A,x.x,*hh<CR><LF>

The $XXHTD sentence is always transmitted (1Hz). It is has many data fields that may or may not be null fields depending on the mode and status of the Autopilot and associated sensors and inputs, (see Table TM1.3.1).

TM1.3: Chan. 1 Track Data Output (Continued).



Chan. 2 NMEA Status Outputs:-
Output terminals 119 (B), 120 (A), 121 (GND) of 888G Distribution Unit:-

Rudder Order:-

$XXROR,x.x,A,x.x,A,a*hh<CR><LF>

Where: $ = start of sentence
XX = talker identifier (don't care)
x,x,A, = Stbd rudder order (A = valid, V = invalid)
x,x,A, = Port rudder order (A = valid, V = invalid)
a* = Command source location
*hh = checksum

Thruster Control Data:-

$XXTRC,x,x.x,a,x.x,a,x.x,a,a*hh<CR><LF>

Autopilot Mode / $xxHTD Field	Standby	On (or Track with no track data received)	On with remote power steer active (NFU, FU or DODGE)	Remote Standby
Override A=active V=inactive	V	V	A	A
Commanded rudder angle	Null	Active	Active	Null
Commanded rudder direction L=Port R=Starboard	Null	Active	Active	Null
Steering mode (see Note 1)	M	S	S	M
Turn Mode (see Note 2)	Null	T, R or N.	N	Null
Rudder limit	Null	Active if on.	Null	Null
Off heading limit	Null	Active	Null	Null
Commanded radius of turn (n.miles).	Null	Active if Radius Turn control selected.	Null	Null
Commanded rate of turn (°/min)	Null	Active if Turn Rate control selected.	Null	Null
Heading to steer	Null	Active	Null	Null
Commanded track	Null	Null	Null	Null
Heading reference in use (T= True, M=Mag)	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.
Rudder status, A= within limit V= limit exceeded	Null	Active if rudder limit on.	Null	Null
Off heading status, A=within limit V=limit exceeded	Null	Active	Null	Null
Vessel heading	Active if heading sensor OK	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK

Table TM1.3.1 - $xxHTD Field details.

Note 1. Steering Mode - M=Manual, S=Stand-alone, H=Heading control via “heading to steer” input data, T= track control (no XTE correction applied by Autopilot), R= Rudder control via “commanded rudder angle” and “commanded rudder direction” fields from input $xxHTC sentence received from track control system.

Note 2. N=Turn not controlled, T=turn rate controlled, R=radius controlled.

Autopilot Mode / $xxHTD Field	Track. HSC or APB sentence in use.	Track. HTC sentence, steering mode "S" in use	Track. HTC sentence, steering mode "H" in use	Track. HTC sentence, steering mode "T" in use	Track. HTC sentence, steering mode "R" in use
Override A=active V=inactive	V	V	V	V	V
Commanded rudder angle	Active	Active	Active	Active	Active
Commanded rudder direction L=Port R=Starboard	Active	Active	Active	Active	Active
Steering mode (see Note 1)	H	S	H	T	R
Turn Mode (see Note 2)	T, R or N.	T, R or N.	T, R or N.	T, R or N.	N
Rudder limit	Active if on.	Active if on.	Active if on.	Active if on.	Null
Off heading limit	Active	Active	Active if HTC Off Hdg field valid. Otherwise null.	Active if HTC Off Hdg field valid. Otherwise null.	Null
Commanded radius of turn (n.miles).	Active if Radius Turn control selected.	Active if Radius Turn control selected.	Active if Radius Turn control selected.	Null	Null
Commanded rate of turn (°/min)	Active if Turn Rate control selected.	Active if Turn Rate control selected.	Active if Turn Rate control selected.	Active if Turn Rate control selected.	Null
Heading to steer	Active	Active	Active	Null	Null
Commanded track	Null	Null	Null	Active	Null
Heading reference in use (T= True, M=Mag)	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.
Rudder status, A= within limit V= limit exceeded	Active if rudder limit on.	Active if rudder limit on.	Active if rudder limit on.	Active if rudder limit on.	Null
Off heading status, A=within limit V=limit exceeded	Active	Active	Active	Active	Null
Vessel heading	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.	Active if heading sensor OK.

Table TM1.3.1 - $xxHTD Field details (continued).

TM1.4: Rudder Reference Unit (NT920RRU).

The position of the rudder is sensed by a 2K-ohm conductive plastic potentiometer mounted in the NT920RRU. Two limit switch cams are attached to the potentiometer shaft, which is connected via universal coupling to a stainless steel input shaft. The input shaft is coupled to the rudder stock (or alternative mechanical reference point which accurately reflects the final position of the rudder) via a gunmetal arm and stainless steel pushrod fitted with ball joints at both ends.

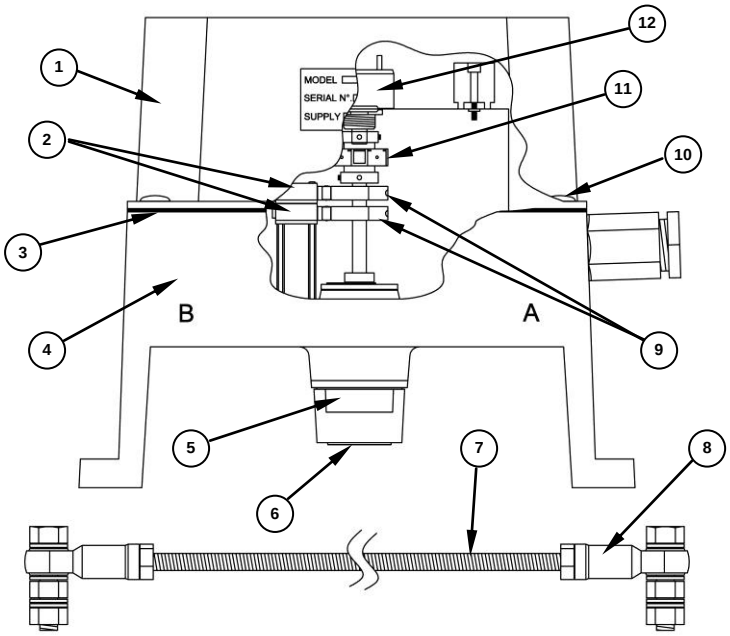


FIG TM 1.4A

Ident	Description
1	Lid Casting
2	Limit Switches
3	Rubber Gasket
4	Base Casting
5	Gunmetal Arm
6	Stainless Steel Input Shaft
7	Stainless Steel Pushrod
8	Ball Joint
9	Limit Switch Cams
10	M6x16mm Panhead screw
11	Universal Coupling
12	2K ohm Pot

Anything other than minimal free play in the coupling path from potentiometer shaft to rudder stock will promote instability (rudder hunting). It is therefore imperative to ensure that all nuts/bolts are tight and that the overall integrity of mechanical movement is backlash free.

The standard Navitron 2K ohm potentiometer is based on a track arc of 100° and is connected across an isolated 5Vdc regulated supply derived from the NT888G Distribution Unit. Based on X:Y coupling ratio of 1.5:1, a nominal 33mV per degree of rudder movement results as a feedback (wiper) signal on terminal N°67 of the Distribution Unit. (Installation section Fig 2.1 refers).

This value (33mV/°) is mid range in the signal level acceptable by the Autopilot thus 1.5:1 is the recommended coupling ratio.

(Installation section 1.6 / Fig 1.6.1 refers)

However, provided the standard 2K potentiometer is employed, any X:Y ratio between 1:1 and 2:1 will prove acceptable.

N.B. If repair circumstances force replacement of the standard 2K ohm potentiometer with a different type, refer to the application note in section TM3.2 for suitability.

TM1.4: Rudder Reference Unit (NT920RRU) Continued.

Limit Switches: -

The NT920RRU also contains normally closed port and starboard limit switches that are mechanically activated by the cams carried on the potentiometer shaft. If the mechanical limit switches are used in addition to, or instead of the electronic limit facility (Installation sections 3.1 and 3.21 refer) the cams must be correctly adjusted (M3 Allen key required) to:-

(i) Prevent the rudder being driven to mechanical extremes.

(ii) Prevent premature arrest of the rudder.

The standard mechanical limit switch configuration breaks the low voltage drives to photovoltaic devices that in turn drive 2 sets of isolated power FETs to provide the solenoid switchlines (Fig TM3.3 refers).

Premature rudder arrest due to an open circuit limit switch condition is signalled by NT888G Control Unit Display screen indication of "**L/SW OPEN**".
In all cases, when a Port or Stbd rudder demand is generated by the Autopilot system, a corresponding Red or Green control panel arrow will be illuminated and should always result in 2 x Red LEDs (LED 1 before and LED 2 after the Port limit switch) and 2 x Green LEDs (before and after the Stbd switch).

These LEDs provide further visual diagnostic aids in the event of a fault condition and are mounted on the Connector PCB located in the Distribution Unit (FIG TM3.3 refers).

Other RRU Fault Indications: -

RRU FAIL:-
Illogical or inconsistent change of feedback potentiometer wiper voltage detected consistent with pot track defect or associated connections. (See section TM2).

STEER`G FAIL:-
(Steering Fail) - No movement of rudder reference unit feedback potentiometer wiper detected in response to rudder demand. (See section TM2).

Rudder Reference Units Types

The standard rudder reference unit contains 2 Limit switches (Port and Stbd) and a single 2K Ohm conductive plastic potentiometer. (FIG TM1.4B refers).

A dual rudder reference unit may also be installed and contains 4 Limit switches (2 x Port and 2 x Stbd) in addition to 2 x electrically isolated CP potentiometers.
(FIG TM1.4C refers).

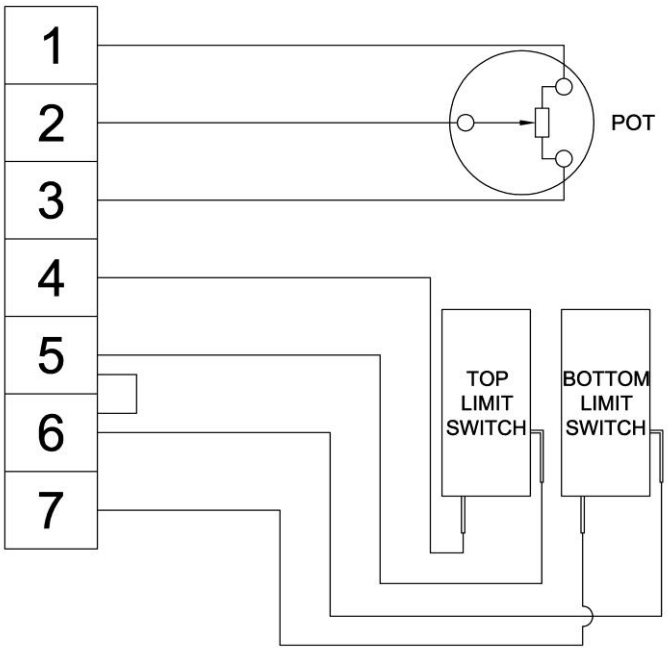


FIG TM1.4B – Standard Rudder Reference Unit.

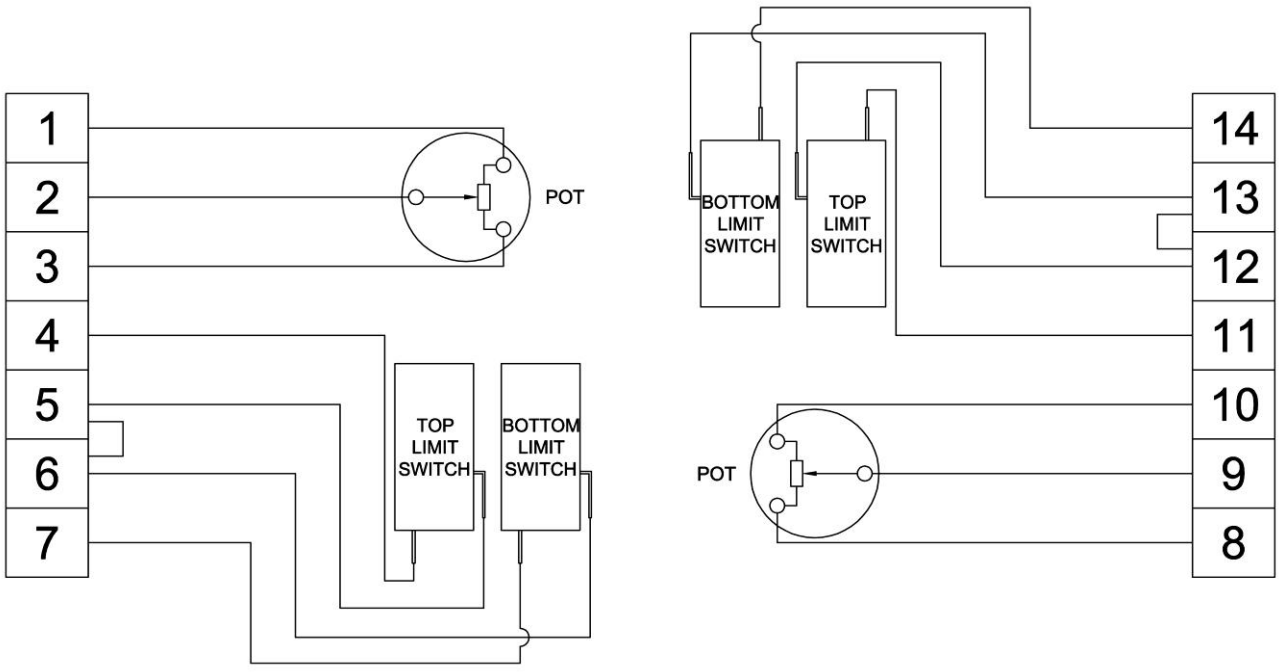


FIG TM1.4C – Dual Rudder Reference Unit.

TM1.5: The Autopilot Control Unit.

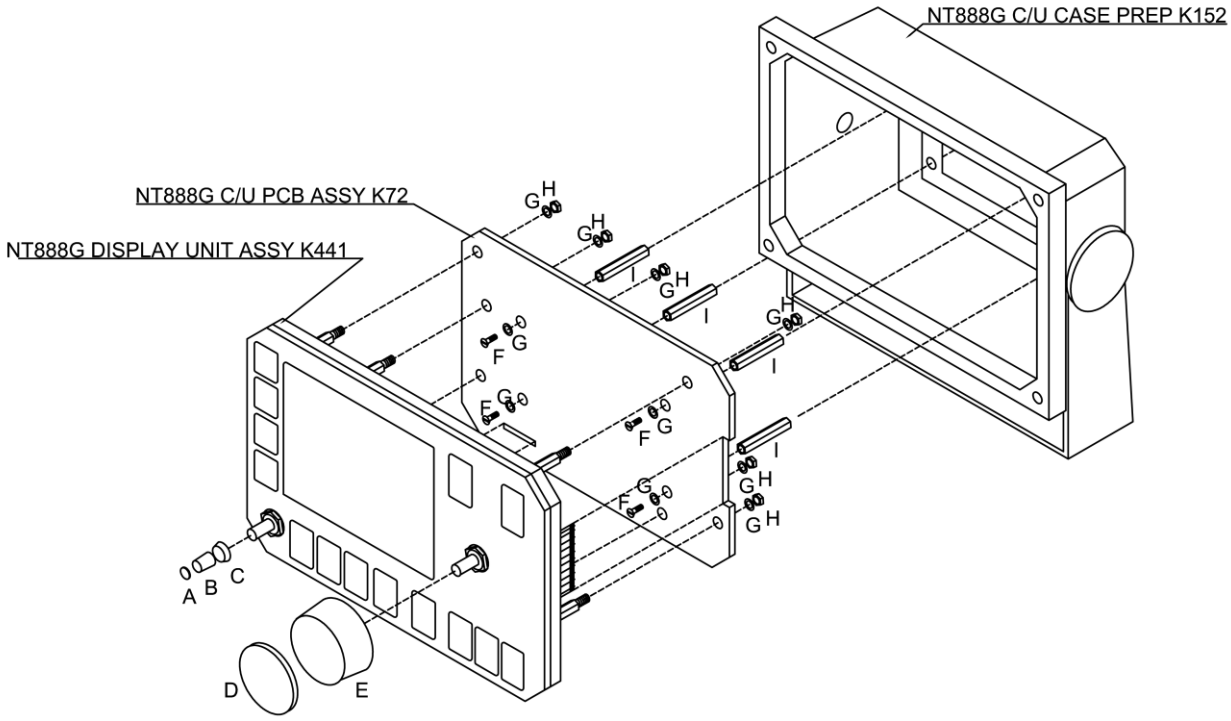
The Autopilot control unit comprises two printed circuit boards – one of which is integral with the Navitron custom programmable LCD display. The resultant PCB sub assembly is mounted to the Control Unit panel and a ribbon connector joints the control panel keypads to the PCB sub assembly.

Cable entry to the Control Unit is via cable gland on a removable backplate which is terminated in PCB mounted plug/socket connectors to permit straightforward Control Unit replacement.

TM1.5.1: The Control Unit Front Panel Sub Assembly.

The front panel assembly comprises the control panel with graphic layer which is attached via pillar mounts to the PCB and the entire assembly is clamped within the aluminium diecast case assembly via 4 x M3 countersink screws located on the backplate flange.

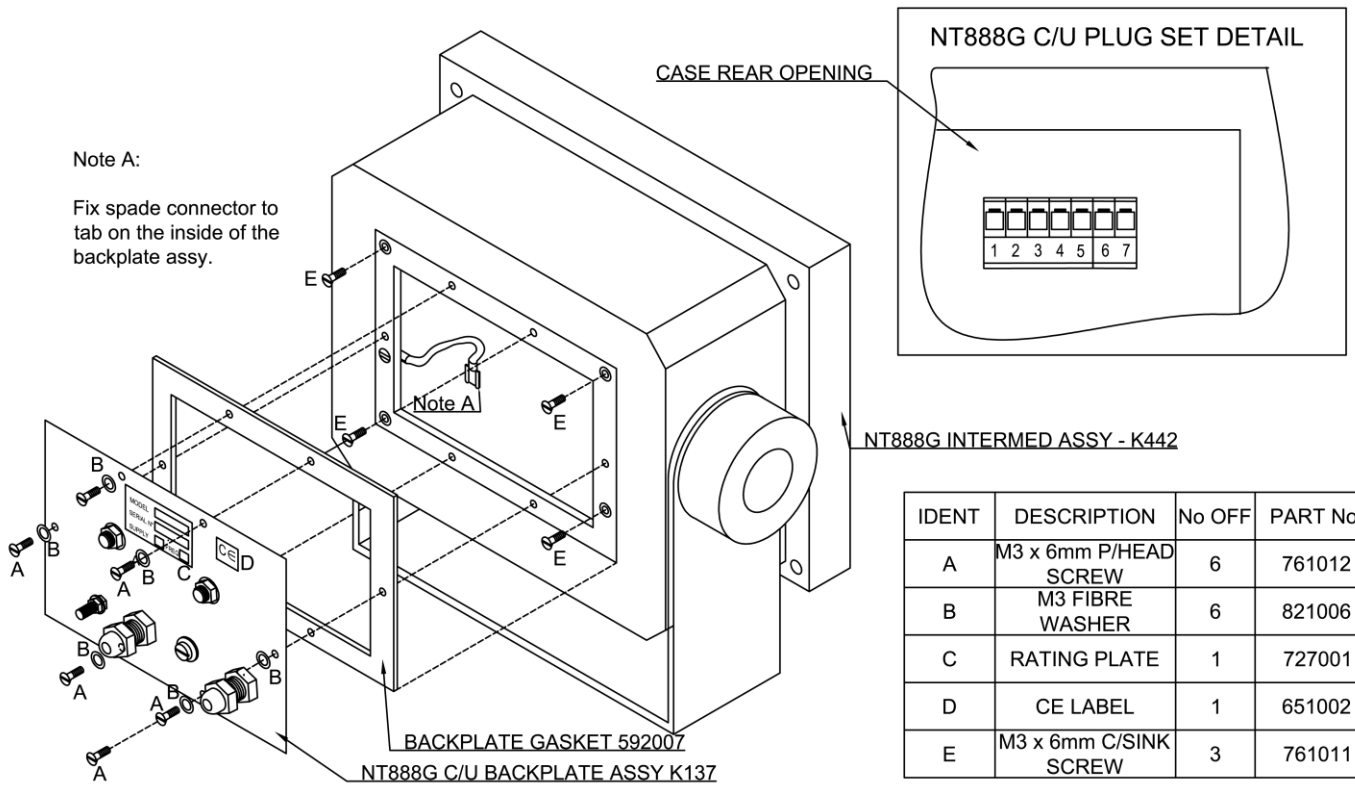
The backplate is retained to the case flange via 6 x M3 c/sk screws and also holds reversible studs used when panel mounting the Control Unit. (FIG TM1.5).



IDENT	DESCRIPTION	No OFF	PART No.
A	SMALL CAP C150	1	641017
B	COLLET KNOB S150 006	1	641016
C	NUT COVER N150	1	641018

IDENT	DESCRIPTION	No OFF	PART No.
D	LARGE CAP	1	641012
E	38mm COLLET KNOB	1	641001
F	M3 x6mm P/HEAD SCREW	4	761012

IDENT	DESCRIPTION	No OFF	PART No.
G	M3 SHAKEPROOF WASHER	10	821004
H	M3 HEX NUT	6	691002
I	M3 x 30mm F/F HEX PILLAR	4	724007



IDENT	DESCRIPTION	No OFF	PART No.
A	M3 x 6mm P/HEAD SCREW	6	761012
B	M3 FIBRE WASHER	6	821006
C	RATING PLATE	1	727001
D	CE LABEL	1	651002
E	M3 x 6mm C/SINK SCREW	3	761011

FIG TM1.5 – NT888G Control Unit Assembly Details

TM1.6: The Track Function.

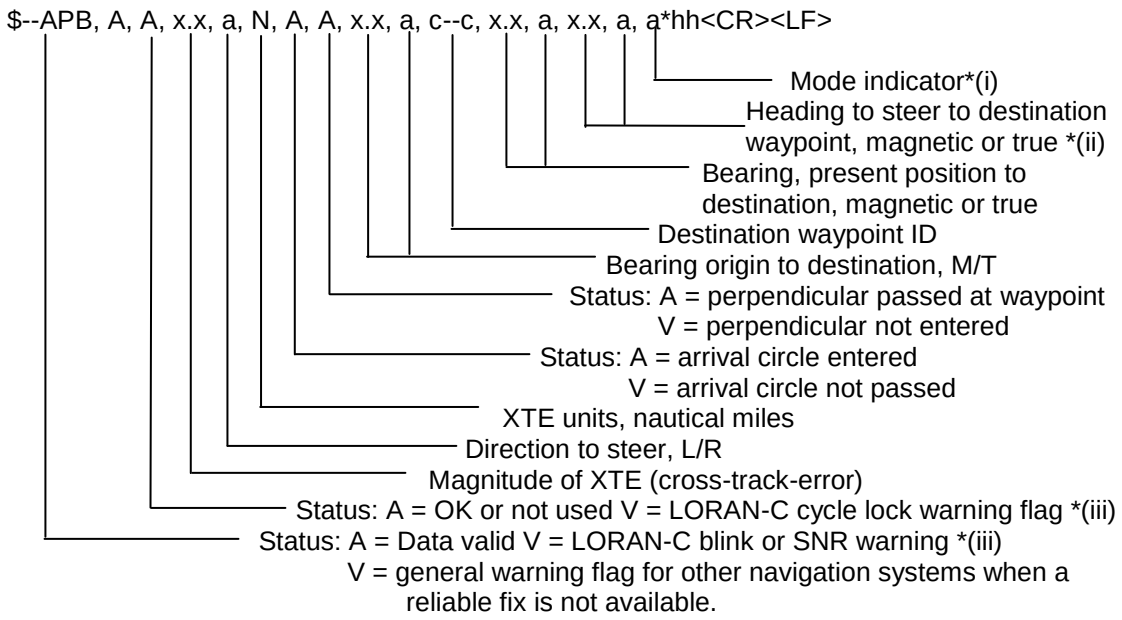
The Autopilot may be operated in track control mode when it will steer the vessel along a pre-planned track or multiple tracks in response to “heading to steer” data from a proprietary track control system. Track mode is engaged by operation of the “TRACK” key pad in the Autopilot “ON” mode.

N.B. The NT888G Autopilot is a “wheelmarked” Autopilot with an approved track steering facility provided the latter is used in conjunction with a Type Approved track control system compliant with IEC62065.

The Autopilot will accept IEC61162/1 or /2 (NMEA0183) data from the proprietary track control system in the HTC, HSC or APB sentences. The checksum must be present for the sentence to be accepted.

TM1.6.1: Use of APB sentence.

APB - Heading/Track controller sentence B definition.



* Data used by NT888G.

i) Mode indicator must be “A” (Autonomous) or “D” (differential).
ii) Heading to steer data is used as set course data.
iii) Cycle lock warning flag and blink or SNR warning flags must be “A” (valid).

At initial engagement of track steering, new track heading must be accepted by pressing the CONFIRM key.

Subsequent course changes of less than 10° will be accepted and acted upon automatically.

Course changes in excess of 10° will require confirmation via CONFIRM key press.

TM1.6.2: Use of HSC sentence

HSC – Heading steering command sentence definition.

Mag or True commanded heading is selected based on heading sensor in use and is accepted as set course data.

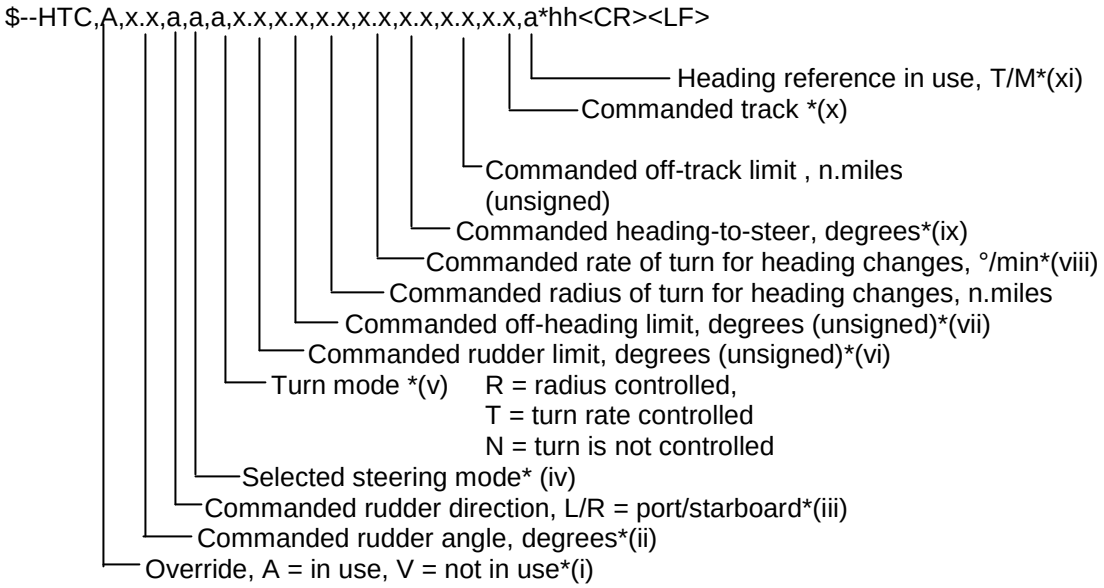
At initial engagement of track steering, new heading must be accepted by pressing the CONFIRM key.

Subsequent course changes of less than 10° will be accepted and acted upon automatically.

Course changes in excess of 10° will require confirmation via CONFIRM key press.

TM1.6.3: Use of HTC sentence.

HTC – Heading/Track control command.



i) Override - If the override field is set to “A” (active) the autopilot will be in standby mode. Otherwise the override field must be “V”.

ii & iii) Commanded rudder angle and commanded rudder direction – These fields specify the absolute commanded rudder angle (in degrees) and direction and are used if the selected steering mode field is set to “R”. If the steering mode field is not set to “R” these fields are ignored.

iv & v) Selected Steering mode and Turn mode – These fields specify the steering mode and turn mode of the autopilot as follows:-

TM1.6.3: Use of HTC sentence (Continued).

HTC STEERING MODE	HTC TURN MODE	COMMENT
S (stand-alone)	N (not controlled)	Autopilot will be in normal stand-alone heading control mode. If the rudder limit and/or off-heading limit fields contain valid data then these values will override the autopilots own internal values. Internal rate of turn control will be used if enabled.
S (stand-alone)	R (Radius controlled)	Autopilot in stand-alone heading control mode. If commanded turn radius field contains valid data this will be used and will override internal value. If no HTC turn radius data available then internal control will be used if enabled. If the rudder limit and/or off-heading limit fields contain valid data then these values will also override the Autopilots own internal values.
S (stand-alone)	T (Turn rate controlled)	Autopilot in stand-alone heading control mode. If commanded rate of turn field contains valid data this will be used and will override internal value. If no HTC rate of turn data available then internal control will be used if enabled. If the rudder limit and/or off-heading limit fields contain valid data then these values will override the Autopilots own internal values.
H (heading)	N (not controlled)	Heading to steer field is used as set course. Internal rate of turn control is used if enabled. Off-heading limit is set to HTC commanded value or set to off, internal offheading limit is not used. Rudder limit is set to HTC commanded value or internal value.
H (heading)	R (Radius controlled)	Heading to steer field is used as set course. HTC commanded radius of turn value is used to override internal value. Off-heading limit is set to HTC commanded value or set to off - internal off-heading limit is not used. Rudder limit is set to HTC commanded value or internal value.
H (heading)	T (Turn rate controlled)	Heading to steer field is used as set course. HTC commanded rate of turn value is used to override internal value. Off-heading limit is set to HTC commanded value or set to off, internal off-heading limit is not used. Rudder limit is set to HTC commanded value or internal value.
T (track)	N (not controlled)	Commanded track field is used as set course. (Note: Due to type approval requirements cross track error is not used to correct track). Internal rate of turn control is used if enabled. Off-heading limit is set to HTC commanded value or set to off, internal off-heading limit is not used. Rudder limit is set to HTC commanded value or internal value.
T (track)	R (radius)	Commanded track field is used (Note: Due to type approval requirements cross track error is not used to correct track). HTC commanded radius of turn value is used to override internal value. Off-heading limit is set to HTC commanded value or set to off - internal off-heading limit is not used. Rudder limit is set to HTC commanded value or internal value.
T (track)	T (Turn rate controlled)	Commanded track field is used (Note: Due to type approval requirements cross track error is not used to correct track). HTC commanded rate of turn value is used to override internal value. Off-heading limit is set to HTC commanded value or set to off, internal off-heading limit is not used. Rudder limit is set to HTC commanded value or internal value.
R (rudder)	Not applicable	Autopilot acts as a slave rudder positioning system. Rudder position is defined by the HTC commanded rudder angle and direction fields.

TM1.6.3: Use of HTC sentence (Continued).

(vi) **Commanded Rudder Limit** – If this field contains valid data (not null) it will be used to override the Autopilot rudder limit setting.

(vii) **Commanded Off Heading Limit** – If the field contains valid data (not null) it will be used to override the Autopilot Off HDG Alarm trip setting. If this field is not present in steering modes “H” and “T” then the Off HDG Alarm will be OFF. This is to avoid conflicting alarms with the Track control systems own Off Heading Alarm system.

(viii) **Commanded Rate of Turn & Commanded Radius of Turn** – If these fields contain valid data they will be used when the Turn Mode is set to “T” (ROT) or “R” (Radius). The value in each case will be used to override the Autopilot internal ROT or Radius set values. As a safety feature the commanded rate of turn value will be limited to the maximum safe limit specified in the Autopilot set-up table during installation. If the turn mode is set to a value other than “T” or “R” or, if the commanded rate of turn field – or commanded radius of turn field - is invalid, the set ROT value or radius value will revert to the Autopilot internal set value.

(ix) **Heading to Steer** – This field is calculated by the track control system taking into account some or all of the following parameters:-
required track, cross track error, next waypoint, radius or rate of turn, vessel speed and characteristics, set and drift. The Autopilot will accept this field (HTS) and steer on the commanded heading. At initial engagement of track steering the new heading must be accepted by pressing the CONFIRM key.
Subsequent course changes will be acted upon immediately without confirmation.

(x) **Commanded Track** - This field is only used when the Turn mode field is set to “R” (Radius). It is used when the track control system outputs dynamically adjusted track heading in this field to achieve a radius controlled turn.

Due to Type Approval requirements the Autopilot does not accept cross track error & does not automatically adjust the commanded track to compensate for cross track error.

(xi) **Commanded Heading Reference in Use** – The Autopilot will accept this field and will use it to switch between Magnetic and True (Gyro) heading references. This data will override the Autopilot Mag & True priorities selected in the Set Up Menu to ensure that the “heading to steer” and actual vessel heading are based on the same reference data.

Section TM2: Warnings, Fail Alarms and Messages.

TM2.1: Power Up Failure Messages.

- **TM2.1.1: SET DAT FAIL (Non volatile Set Up data failure load).**
- **TM2.1.2: DATA ERROR (Corrupted DB data).**
- **TM2.1.3: COMM FAIL (CU to DB data communication failure).**

TM2.2: Heading Sensor Failure Messages.

- **TM2.2.1: CPS HI FAIL (Signal from HSC is too large).**
- **TM2.2.2: CPS LO FAIL (Signal from HSC is too small).**
- **TM2.2.3: CPS PHS FAIL.**
- **TM2.2.4: COMPASS FAIL.**
- **TM2.2.5: HDT 1 FAIL.**
- **TM2.2.6: HDG 1 FAIL.**
- **TM2.2.7: HDM 1 FAIL.**
- **TM2.2.8: HCC 1 FAIL.**
- **TM2.2.9: HDT 2 FAIL.**
- **TM2.2.10: HDG 2 FAIL.**
- **TM2.2.11: HDM 2 FAIL.**
- **TM2.2.12: HCC 2 FAIL.**
- **TM2.2.13: NO NMEA H`DG IN.**
- **TM2.2.14: CCA DAT FAIL.**

TM2.3: Miscellaneous Failure Messages.

- **TM2.3.1: MAIN PWR FAIL.**
- **TM2.3.2: BACK PWR FAIL.**
- **TM2.3.3: D.BOX FAIL.**
- **TM2.3.4: REMOTE FAIL.**
- **TM2.3.5: NO DATA.**
- **TM2.3.6: RRU FAIL.**
- **TM2.3.7: L/SW OPEN.**
- **TM2.3.8: STEER`G FAIL.**
- **TM2.3.9: MASTER REM. OFF/REMOTE 1 (2) (3) REQUEST.**
- **TM2.3.10: +7V FAIL.**
- **TM2.3.11: +3.5V FAIL.**
- **TM2.3.12: +2.5V FAIL.**
- **TM2.3.13: NO ORIDE CAL.**

TM2.4: Speed Data Alarms.

TM2.4.1: NO SOG DATA.

TM2.4.2: NO STW DATA.

TM2.4.3: SPEED LOW.

TM2.5: Track Mode Data, Warnings & Alarms.

TM2.5.1: HTS DATA.

TM2.6: Operational Alarms.

TM2.6.1: >x° OFF HEADING.

TM2.6.2: CCA LIMIT.

TM2.6.3: WATCH xx MIN.

TM2.6.4: RUDDER LIMIT.

TM2.1.1: SET DAT FAIL (non volatile set up data failure to load).

The Autopilot setup data is stored in the Distribution Unit non-volatile memory and read at power up. The integrity of this data is verified when read and will only be used if no errors are detected. A checksum is included to guard against corrupted data being used.

If the current setup data is unable to be loaded at power up for any reason, the SET DAT FAIL error message will be displayed accompanied by an audible bleep. The Autopilot will continue to function but all setup parameters will be set to their factory default values as listed below.

Setup parameters and their factory default values: -

No.	Type	Def.	No.	Type	Def.
1	Contrast	06	**34**	NMEA Data Type	True
2	Disp Inv.	OFF	**35**	OHA Delay	10sec
3	Rem Dim	ON	**36**	Course Comparator	OFF
4	Loop Gain	1.5°/deg	**37**	Furuno O/P Resolution	1/6
5	Vess Type	Displace	**38**	Furuno O/P Rate	5Hz
6	ROT Scale	°/min	**39**	NMEA Ch.1 i/o baud	4800
7	APH Secs	600	**40**	NMEA Ch.1 I/P baud	4800
8	APH Trip	60°	**41**	NMEA Ch.2 I/P baud	4800
9	APH Mode	STD	**42**	Track baud rate	4800
10	Thrust Enable	ON	**43**	NMEA Speed In Data	4800
11	RRU Type	Standard	**44**	NMEA O/P 2 Spd In 2	4800
12	RRU Rotate 360	0V	**45**	Set Course Alarm	20°
13	Amidships Cal.	00°	**46**	FU In Thrust Cal.	N/A
14	RAI Cal.	33mV/°	**47**	New Crse Alarm Time	30 sec
15	Rudder Bar Cal.	All @ 30°	**48**	OHA Alarm Timeout	30 sec
16	Solenoids	Enable	**49**	Remote Steer ON Alrm	ON
17	Elect. L/sw	OFF	**50**	Auto/Manual Deviation	AUTO
18	Port L/sw	60°	**51**	Ch.A Analogue Output	Pos`n
19	Stdb L/sw	60°	**52**	Ch.A Voltage Offset	000%
20	Rud. Pos. Sens.	0.75°	**53**	Ch.A Voltage Gain	250mV/°
21	Auto Stability	000	**54**	Ch.A Current Offset	000%
22	Lost Motion	OFF	**55**	Ch.A Current Gain	+266μA
23	Lost Motion Cal.	0.04 sec	**56**	Ch.B Voltage Offset	000%
24	Anlog. Str. Alarm.	OFF	**57**	Ch.B Voltage Gain	250mV/°
25	An. Str. Alrm. Limit	2°	**58**	Ch.B Current Offset	000%
26	An. Str. NFU Time	15 sec	**59**	Ch.B Current Gain	+266μA
27	ROT max.	5°/min	**60**	Step O/P (Steps/°)	6
28	ROT Cal.	15°/min	**61**	Step O/P Rate (max.)	8°/sec
29	Coil Type	HSC2	**62**	Isolated FU Steer Mode	NORM
32	Mag Priority	NMEA	**63**	Isolated FU Midship Cal.	0V
33	NMEA Ch. Priority	Ch.1	**64**	Isolated FU Range Cal.	10V/63°

TM2.1.1: Set Dat Fail (non volatile setup data failure to load) … (Continued).

If the Set Dat Fail message appears, switch the Autopilot "OFF". Wait a few seconds then set the Autopilot to STANDBY. If the Set Dat Fail message is again shown when the Autopilot is re-powered, it is likely that the Set Up Menu data is corrupted thus the integrity of the stored setup data must be considered suspect and should be cleared down as follows: -

(i) To enter the Set Up Mode, simultaneously press the "**CANCEL**" and "**CONFIRM**" keys for 5 seconds after which the NT888G display will show a table of Set Up parameters and will highlight the parameter currently selected.

NB. If user data (Set Up parameters established and loaded based on past Autopilot system steering performance) has been stored (Set Up Parameter No. 68) it may be possible to retrieve user data (load per item (ii) below) instead of reloading factory default settings (per item (iii) below).

(ii) To clear the stored Set Up data in favour of proven **User Data** (if available) use the Course Selector to select Parameter number 68 (**LOAD USER DATA**).

Press the "**AUTOTRIM**" key for 5 seconds for countdown and confirmation of User Data Loaded saved by the display message "**DONE**".

(iii) To clear the stored SETUP data in favour of **Factory Default** settings, use the Course Selector to select Parameter number 66 (**FACTORY RESET**).
Press **AUTOTRIM** for a period of 5 seconds during which a display countdown will be shown followed by a long "bleep" and "**DONE**" to confirm factory default settings reinstated. (Release of the **AUTOTRIM** key before the 5 second period will cancel the reset request).

(iv) Exit the Set Up Menu by simultaneously pressing the **CANCEL** and **CONFIRM** keys for a period of 5 seconds confirmed by normal display operation.

TM2.1.2: DATA ERROR (Corrupted DB Data).

This failure message indicates corrupted data received from the Distribution Unit and will occur if the data lines between DB and Control Unit are reversed (DB terminals 41 & 42/45 & 46/49 & 50). The Autopilot will not function until the fault condition is corrected.

TM2.1.3: COMM FAIL (CU to DB data communication failure).

Indicates communication failure between the NT888G Autopilot Control Unit and Distribution Unit due to hardware or software defect if data connections between units are correct. This condition is due to complete absence of data, the autopilot will not function until the fault condition is corrected.

TM2.2: Heading Sensor Failure Messages.

TM2.2.1: CPS HI FAIL (Signal from HSC is too large).

The average signal amplitude can be read via access to the Diagnostic mode and will normally be displayed as a number between 200 and 3840 (Section TM5, Set 6 – MAGNITUDE refers). If the value is above 4095, clipping errors may result when the CPS HI FAIL warning message will be generated.

(i) Check the HSC wiring ensuring that the excitation connections (RED or BLACK) are not crossed with the sense windings (BLUE, WHITE, GREEN).
Installation sections 2.2 and FIG 2.1.2 terminals 71 to 76 refer.

(ii) Check power supply and reference voltages per Section TM4.2.

(iii) If the above tests are good, the field strength of the compass magnet may be too high in relation to the proximity of the HSC. In this event, if will be necessary to move the HSC further away from the magnet by introducing a non-ferrous spacer between coil and compass.

TM2.2.2: CPS LO FAIL (Signal Amplitude from HSC too low).

The average signal amplitude can be read via access to the Diagnostic mode and will normally be displayed as a number between 200 and 3840 (Section TM5, Set 6 – MAGNITUDE refers). If the value is below 200, heading calculation errors may result when the CPS LO FAIL warning message will be generated.

(i) Check wiring and connection integrity of HSC to compass junction box and Autopilot (Installation Section 2.2 and FIG 2.1.2 Terminals 71 to 76 refer).

(ii) Check for open circuit HSC excitation winding: -
Remove plug from Dist. Unit main terminal block (Nos. 71 to 76).
Check excitation-winding resistance (approx 25 ohms) between plug Terminals 75 (BLACK) and 74 (RED).

(iii) If the excitation winding resistance is confirmed at approx 25 ohms, reinsert the plug (Terminals 71 to 76) and remove the wire from Terminal No.3. Check for 3.5Vdc between the free wire end and Terminal No.8 with the Autopilot MODE switch set to STANDBY. Replace the wire and repeat for Terminal Nos. 4 and 5 with respect to Terminal No.8.

TM2.2.2: CPS LO FAIL (Signal Amplitude from HSC too low) … (Continued).

NB. If wiring and connection integrity is confirmed (item (i)) followed by suspect readings in (ii) or (iii) replace the HSC (Installation Sections 1.3 and 2.2 refer).

TM2.2.3: CPS PHS FAIL (Signals from the 3 sense lines are not consistent).

This error message indicates that the HSC star winding phases are unbalanced preventing accurate heading calculations and is typically due to wiring defects between Autopilot Distribution Unit and HSC or an internal HSC fault.

(i) Check power supplies and reference voltages per Section TM 4.2.

(ii) Check HSC wiring and connections at the compass junction box and Distribution Unit (Installation Sections 2.2 and FIG 2.1.2 Terminals 71 to 76 refer).

(iii) Check the HSC star windings in accordance with TM2.2.2 item (iii).

NB. If no fault area can be identified, the HSC must be regarded as suspect and should be replaced (Installation Sections 1.3 and 2.2 refer).

TM2.2.4: COMPASS FAIL (High ROT/Rate of change).

This is a software generated warning message based on a Heading Sensor Coil signal (HSC attached to Mag compass) that exhibits a sudden and illogical change (i.e. physically impossible for the vessel to achieve) indicating an open circuit star winding or similar.

(It should be noted that transient movements in HSC heading signal levels are filtered in software to prevent unnecessary/unwanted alarm generation).

When an unreasonable rate of change of heading has been detected from the HSC heading signal (+/-15° for more than 4 seconds) the HSC input sentence will be inhibited and will not be re-enabled until the Autopilot MODE switch is set to STANDBY.

If the Compass Fail alarm persists:-

(i) Check power supplies and reference voltages per Section TM 4.2.

(ii) Check HSC wiring and connections at the compass junction box and Distribution Unit (Installation Sections 2.2 and FIG 2.1.2 Terminals 71 to 76 refer).

(iii) Check the HSC star windings in accordance with TM2.2.2 item (iii).

NB. If no fault area can be identified, the HSC must be regarded as suspect and should be replaced (Installation Sections 1.3 and 2.2 refer).

TM2.2.5: HDT 1 FAIL (Channel 1 input).

An unreasonable rate of change of heading has been detected in the HDT (NMEA 0183) heading data. The HDT sentence has been inhibited and will not be re-enabled until the Autopilot MODE switch is set to STANDBY.
Check proprietary heading source.

(It should be noted that transient movements in HDT heading data levels are filtered in software to prevent unnecessary/unwanted alarm generation).

It is also noteworthy that should the HDT data still be suspect when the Autopilot is switched to “ON”, the next (lower) priority NMEA sentence will be read, and in the event that the higher priority sentence is restored, this will automatically be accepted provided the heading value is within 15° of the current heading.

TM2.2.6: HDG 1 FAIL (Channel 1 input).

An unreasonable rate of change of heading has been detected in the HDG (NMEA 0183) heading data. The HDG sentence has been inhibited and will not be re-enabled until the Autopilot MODE switch is set to STANDBY.
Check proprietary heading source.

NB. The comments made in TM2.2.5 reference filtering and 15° restoration provided within 15° of current heading are applicable to the HDG sentence.

TM2.2.7: HDM 1 FAIL (Channel 1 input).

An unreasonable rate of change of heading has been detected in the HDM (NMEA 0183) heading data. The HDM sentence has been inhibited and will not be re-enabled until the Autopilot MODE switch is set to STANDBY.
Check proprietary heading source.

NB. The comments made in TM2.2.5 reference filtering and 15° restoration provided within 15° of current heading are applicable to the HDM sentence.

TM2.2.8: HCC 1 FAIL (Channel 1 input).

An unreasonable rate of change of heading has been detected in the HCC (NMEA 0183) heading data. The HCC sentence has been inhibited and will not be re-enabled until the Autopilot MODE switch is set to STANDBY.
Check proprietary heading source.

NB. The comments made in TM2.2.5 reference filtering and 15° restoration provided within 15° of current heading are applicable to the HCC sentence.

TM2.2.9: HDT 2 FAIL (Channel 2 input).

As TM2.2.5.

TM2.2.10: HDG 2 FAIL (Channel 2 input).

As TM2.2.6.

TM2.2.11: HDM 2 FAIL (Channel 2 input).

As TM2.2.7.

TM2.2.12: HCC 2 FAIL (Channel 2 input).

As TM2.2.8.

TM2.2.13: NO NMEA H`DG IN (No heading data).

This alarm condition confirms that no NMEA heading data of any type is being received by the Autopilot system. Check proprietary source(s).

TM2.2.14: CCA DAT FAIL (CCA NMEA data fail).

This alarm condition occurs if only one heading data input (no second heading data input) is available for comparison purposes. The CCA will function with 2 heading inputs and will compare the 2 highest priority sources nominated via the Autopilot Set Up Menu. Check proprietary source(s).

TM2.3: Miscellaneous Failure Messages.

TM2.3.1: MAIN PWR FAIL (Main power).

In the event of Main Power supply failure (11-40Vdc) to Terminals 47 (+ve) and 48 (-ve) of the Distribution Unit, a Main Power supply fail message will be displayed on the Control Unit accompanied by audible internal alarm.

NB. A Power Monitor relay is also provided within the DB to offer voltfree single pole changeover contacts to activate an external (auxiliary) alarm (if required) in the event of complete (Main & Back Up) power supply failure.

TM2.3.2: BACK PWR FAIL (Back up power).

In the event of Back Up power supply failure (11-40Vdc) to terminals 49 (+ve) and 50 (-ve) of the Distribution Unit, a Back Up power supply fail message will be displayed on the Control Unit accompanied by audible internal alarm.

NB. A Power Monitor relay is also provided within the DB to offer voltfree single pole changeover contacts to activate an external (auxiliary) alarm (if required) in the event of complete (Main & Back Up) power supply failure.

TM2.3.3: D. BOX FAIL (Distribution Unit).

Indicates internal Distribution Unit failure associated with communication break down between processors. It is likely that factory advice/assistance will be required.

TM2.3.4: REMOTE FAIL (Control Unit communication).

This condition indicates no data received by the DB from the Control Unit.

TM2.3.5: NO DATA (No user data stored).

This alarm is generated when attempting to reprogramme the Set Up Menu values with stored data (previously set for optimum steering performance) where no user data is available in the user data memory location.

TM2.3.6: RRU FAIL (Rudder Reference Unit failure).

This error message warns that an abnormally high rate of change or step voltage change has been detected from the rudder reference unit potentiometer, which is used to signal rudder position.

This might be caused by a “noisy” or open circuit potentiometer track, damaged wiring or intermittent feedback connections. Loose joints or “backlash” in the mechanical linkage between rudder reference unit and rudder stock may also be a contributory factor.

The NT888G Control Unit display provides 2 digit rudder angle data and can be used to provide an accurate indication of the rudder reference unit potentiometer integrity as follows: -

(i) Set the Autopilot to **STANDBY** and use manual steering control to move the rudder from hard over Port to hard over Stbd observing the 2-digit display in the process. If the indicated rudder angle fails to follow the rudder smoothly and accurately, a potentiometer fault is indicated.

(ii) Check the integrity of the +5Vdc potentiometer supply (Distribution Unit Terminals 66 and 68 - Installation Section FIG 2.1.2) and Terminals 1 and 3/9 and 10 in FIG TM1.4B or C as appropriate).

(iii) If the potentiometer supply voltage is stable but the wiper signal is erratic at the rudder reference unit (Terminal 2/9 FIG TM1.4 B or C) a loose pot coupling or defective pot track is indicated within the reference unit. (Check item 11 FIG 1.4A and replace potentiometer if necessary – see Section TM3.2).

(iv) Check mechanical linkage between rudder reference unit and the steering system coupling point for smooth and unrestricted movement.

TM2.3.7: L/SW OPEN (Limit switch status).

This is an operational status alarm applicable to both Port and Stbd limit switches and is displayed on the Control Unit if either limit switch is rendered open circuit.

TM2.3.8: STEER`G FAIL (Steering system fail).

Solenoid Steering System.

This alarm is activated if the Autopilot has issued a rudder movement demand but the steering system has failed to respond within a period of two seconds.

For NT888G DB microprocessor 1 software version prior to V1.78 the alarm is automatically cancelled when the rudder starts to move. For NT888G DB microprocessor 1 software version V1.78 and above the alarm will disable the solenoids to prevent the rudder being driven hard over in the event of feedback linkage or signal wire failure. The alarm is cancelled by pressing the “STANDBY / OFF” key on the control unit. The cause of the failure should be investigated prior to re-engaging the Autopilot.

NB:- Steering failure investigation for V1.78 software is facilitated by entering “SET UP” mode and stepping to parameter 13 (section 3.17 RRU MIDSHIPS). Manually move the rudder PORT or STBD, press the control unit “ON” key, the Autopilot will attempt to move the rudder to midships by turning on the appropriate solenoid, if the rudder does not respond no “STEER’G FAIL” alarm is generated therefore the solenoids will remain on, thus fault investigation can be undertaken. Press “STANDBY / OFF” key to disengage the system. Press “CANCEL & CONFIRM” keys for 5 seconds to exit setup.

Likely causes of this type of failure are as follows: -

(i) Steering pump(s) not running.

(ii) Air in hydraulic system causing delayed rudder response.

(iii) Rudder at maximum limit as defined by limit switch settings.

NB. An open circuit limit switch (whether due to adjustment or defect) is signalled by the “L/SW OPEN” alarm display (TM2.3.7). For NT888G DB microprocessor 1 software versions from V1.78 an open circuit limit switch will not cause a “STEER’G FAIL” alarm.

(iv) No rudder demand outputs from Autopilot Control Unit or defective solenoid(s): -

Check Red/Green rudder demand indicators on Autopilot Control Unit panel and solenoid switchlines/supply voltages. (See Installation Sect. 2.10 & FIG 2.1.2).

(v) For solenoid output drive circuit details, refer to Section TM3.1.

ASI Analogue Steering Systems.

Provided continuous rudder position feedback is available and the ASI Steering Fail monitor is turned ON (Section 3.28), the Autopilot will monitor the Rudder position (as indicated by the Rudder Feedback signal) and compare it to the demanded position.

TM2.3.8: STEER`G FAIL (Steering system fail) … (Continued).

When the Rudder approaches the demanded position, if the final position when the rudder has stopped remains greater than the set limit value for more than two seconds, and the rudder is not moving towards the correct position, then the steering fail alarm is activated and the LED is illuminated. The alarm is automatically cancelled if the rudder moves towards the correct position or the error is within the set limit.
Likely causes are: -

(i) Analogue steering machine not operating or not set for Autopilot control.

(ii) Rudder at maximum physical limit.

(iii) Rudder not at demanded angle due to incorrect calibration of Distribution Unit Output Gain.

TM2.3.9: MASTER REM. OFF/REMOTE 1 (2) (3) REQUEST.

This condition advises that Control Unit No. 2 or 3 (as appropriate) request for Autopilot system control has been denied because a Master station (Control Unit No.1) has been nominated and the "**REMOTE**" key of CU No.1 has not been activated (no corner LED illumination = REMOTE CU`s denied entry).

(Control Unit Nos. 2 & 3 will only gain entry when No.1 REMOTE key permits).

TM2.3.10: +7V FAIL.

The +7V regulator is contained within the Distribution Unit and supplies various facilities including the Heading Sensor Coil (HSC on DB Terminal No.74) and is divided to provide the analogue 3.5Vdc reference also.

If the +7V regulated line fails or is outside of design tolerance, the +7V Fail alarm will be activated.

TM2.3.11: +3.5V FAIL.

The +3.5V regulated line is derived from the +7V regulated line within the Autopilot Distribution Unit and is available for measurement on DB term No.80.

If the +3.5V regulated line fails or is outside of design tolerance, the +3.5V Fail alarm will be activated.

TM2.3.12: +2.5V FAIL.

The +2.5V regulated line is derived from the +5V regulated line (DB term No. 66) within the Autopilot Distribution Unit.

If the +2.5V regulated line fails or is outside of design tolerance, the +2.5V Fail alarm will be activated.

TM2.3.13: NO ORIDE CAL (No override cal – HSC requirement).

This alarm confirms that no cal data has been entered during initial High Speed vessel (HSC) installation and sea trials to provide a safe angle of rudder - based on vessel speed and associated safe rate of turn – when the override control is operated. (See section 2.43 & Set Up parameter No.64)

TM2.4: Speed Data Alarms.

TM2.4.1: NO SOG DATA (NMEA speed over the Ground).

Speed over the Ground (SOG) data is essential to Autopilot constant radius turn performance for which NMEA sentence types $XXVTG or $XXVBW must be available.

In the event that these sentence types are absent, the NO SOG DATA alarm will be activated. (Check NMEA Speed Data Source).

TM2.4.2: NO STW DATA (NMEA or pulse log Speed through the Water).

Speed though the Water (STW) data is essential to Autopilot Speed Adaptive performance for which NMEA sentence types $XXVHW or $XXVBW must be available.

Pulse log input (200 or 400ppNm) is also acceptable but in the event that none of these input types are present (No NMEA or Pulse) the NO STW DATA alarm will be activated. (Check NMEA Speed/Pulse Data Source).

TM2.4.3: SPEED LOW (SOG inadequate).

This alarm relates to Speed over the Ground and warns that SOG is too low for the Autopilot system to undertake the programmed/required radius of turn due to prevailing conditions (SOG too low vs drift etc.). **Speed increase required.**

TM2.5: Track Mode Data, Warnings & Alarms.

TM2.5.1: HTS DATA.

This error message will result when the Autopilot is operating in the TRACK mode and no valid (HTC, HSC or APB) track data is being received.

(i) Check proprietary track control system is operating normally and a valid track has been entered and selected.
(ii) Check connections to Terminals 14(A) and 15(B) at the Distribution Unit main terminal block.
(iii) Check data received is in accordance with the NMEA standard (IEC61162/1 or 61162/2) and that at least one of the following sentence types are available with valid heading to steer data: -
HTC, HSC, APB. (See Section TM1.6).

TM2.5.1: HTS DATA … (Continued).

NB. When used with $XXAPB or $XXHSC data, the Autopilot will alarm when a waypoint is reached and a turn in excess of 10° is required to next waypoint.

TM2.6: Operational Alarms.

TM2.6.1: >x° OFF HEADING (Off heading alarm trip level).

The Autopilot LIMITS Menu allows the integral Off Heading Alarm (OHA) trip level to be set such that if the vessel alters course or yaws in excess of the level specified (+/-3°, +/-5° etc.) the Off Heading Alarm will be activated.

TM2.6.2: CCA LIMIT (Course comparator).

The Autopilot is equipped with an integral Course Comparator which compares data received from 2 inputs (1 x HSC and 1 x NMEA or 2 x NMEA). In the event that one input is absent or disagrees with the other by more than the preset limit (preset in the LIMITS Menu) the CCA Limit Alarm will be activated.

TM2.6.3: WATCH xx MIN (3 to 12 min periods).

The watch alarm timeout period is set via the LIMITS Menu for timeout periods between 3 and 12 minutes (as required). When the timeout period completes, an audible low level alarm will commence. (Reset via TEST/OFF key operation).

TM2.6.4: RUDDER LIMIT.

The rudder limit setting is the maximum angle of rudder that the Autopilot system is normally permitted to apply and is set – in degrees – via the LIMITS Menu. In the event that the maximum (limit) angle is attained, the alarm is activated.

Section TM3: Application Notes.

TM3.1: Port & Stbd Solenoid Switching Stages.

TM3.2: The Rudder Reference (Feedback) Potentiometer.

TM3.3: Analogue Outputs to Steering Machines & Thrusters.

TM3.4: Proprietary Remote Power Steer Inputs.

TM3.4.1: Full Follow Up and Non-Follow Up Operating Conditions.

TM3.4.2: Non Follow Up Mode Connections.

TM3.4.3: Full Follow Up Mode Connections.

TM3.4.4: Dodge Mode Connections

TM3.5: Proprietary Wheel and Override Power Steer.

TM3.6: Auxiliary Status Alarm Contacts.

TM3.1: Port & Stbd Solenoid Switching Stages.

The autopilot rudder demands and associated output stages are configured such that the solenoid power supply is separated from, and may be fully floating with respect to the Control Unit electronics power supply. As a result, no common line requirement exists between the Electronic & Solenoid Power supplies, which is particularly convenient in steering systems employing independent rectified dc etc. for solenoid excitation.

Dual solid state Port & Stbd outputs are standard and the solenoids may be connected for common positive (-VE switchlines) or common negative (+VE switchlines) as required and as shown in FIGs **TM3.1.1** and **TM3.1.2** respectively.

When connected for common positive operation, T25/23 and T26/24 (FIG TM3.1.3 refers) function as conventional FET switches to provide -VE switchlines at terminals 60/52 and 62/54 for Port & Stbd solenoids respectively.

When connected for common negative, T25/23 and T26/24 operate as source followers to provide +VE switchlines at terminals 59/51 and 61/53 respectively.

Integrated circuits U34/39 and U38/40 are photovoltaic devices activated by the Port & Stbd rudder demand signals (received from the Distribution Unit main P.C.Board) and provide isolated Gate/Source bias for the solenoid switching transistors T23/25 (Port) and T24/26 (Stbd).

The double pole contacts of Relays 9 & 10 provide failsafe isolation of the solenoids in the event of short circuit damage to output FET's T23/25 and T24/26.

TM3.2: The Rudder Reference (Feedback) Potentiometer.

Whilst all Navitron Autopilot systems are supplied as standard with a Rudder Reference Unit containing Limit switches and a 2K ohm feedback potentiometer, it is useful to note that the Autopilot design flexibility affords compatibility with a wide range of potentiometer types.

This feature enhances the spares and retrofit capability of the Autopilot system in addition to simplifying new installation considerations associated with unconventional rudder and/or steering gear configurations.

As a general rule, and provided always that the quality (resolution and life rating etc.) of any alternative potentiometer employed is commensurate with Autopilot application, compatibility is dependent upon the availability of wiper voltage change of between 7mV and 65mV per degree of rudder movement.

Provided the level of wiper voltage change is between the limits of 7mV and 65mV per degree of rudder movement, the Autopilot system will calibrate to produce internally an absolute reference of 54.9mV/degree.

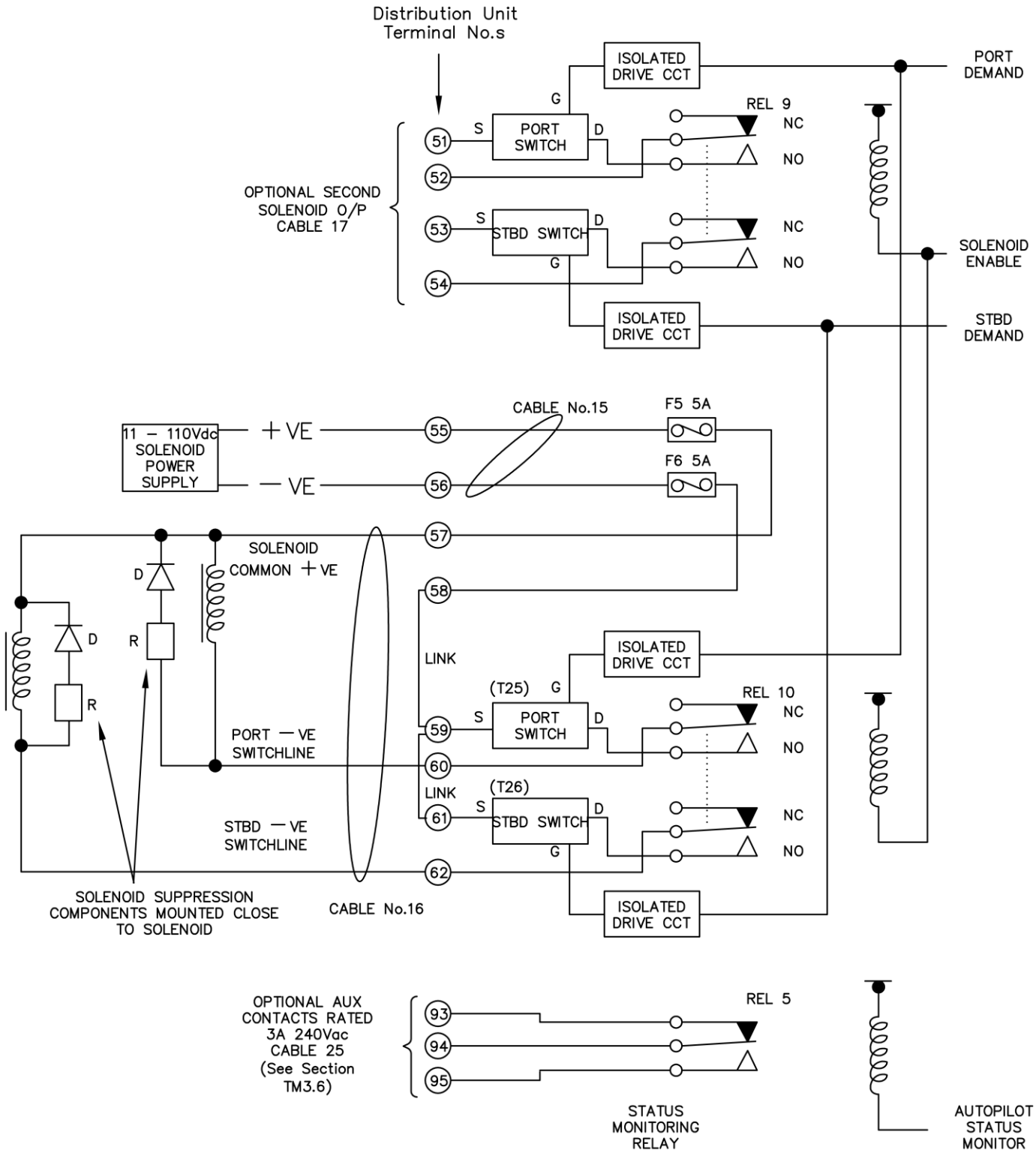


FIG TM3.1.1 Autopilot Distribution Unit Connector PC Board Terminal Block Functions When Solenoids Are Connected For Common Positive.

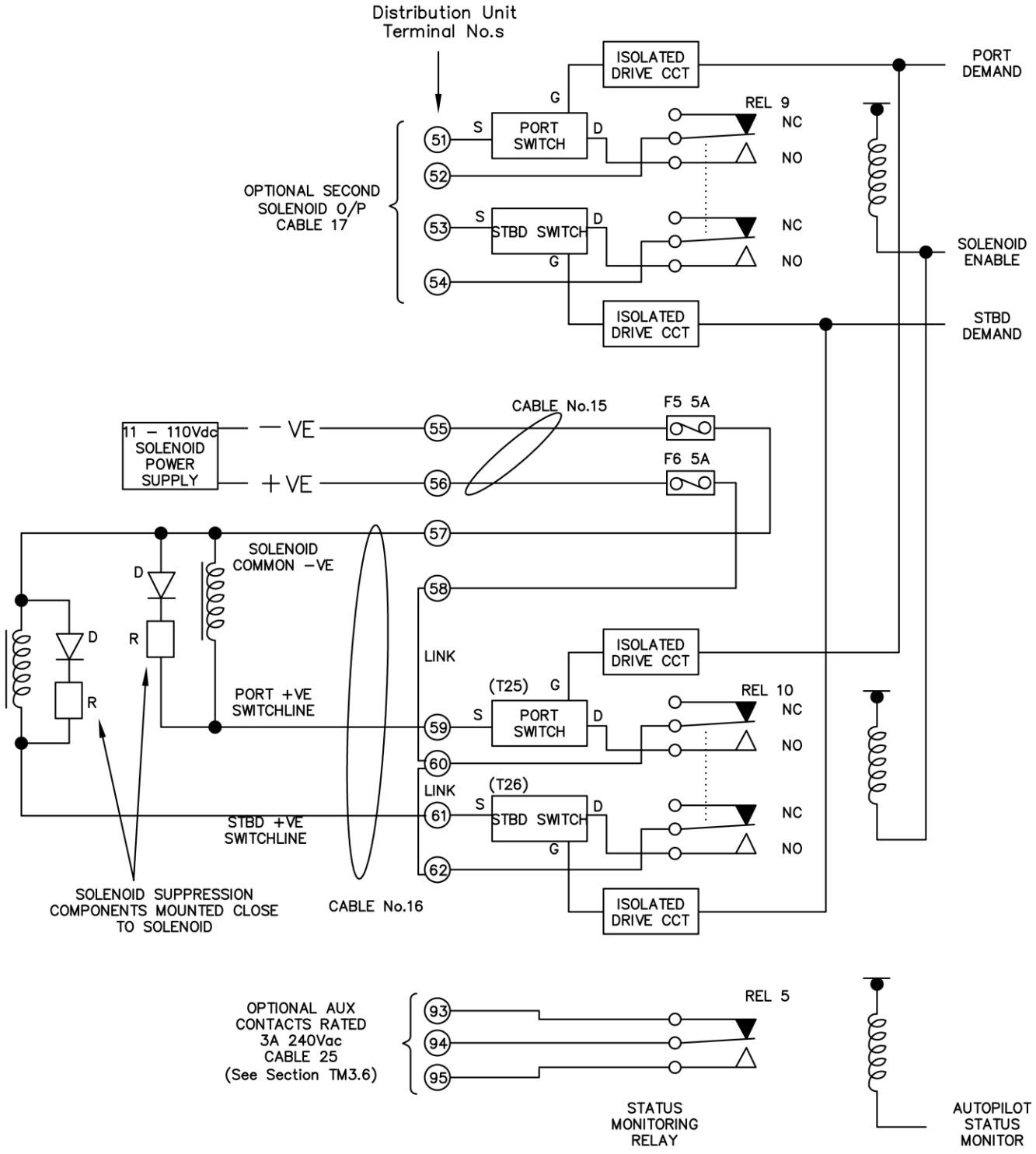


FIG TM3.1.2 Autopilot Distribution Unit Connector PC Board Terminal Block Functions When Solenoids Are Connected For Common Negative.

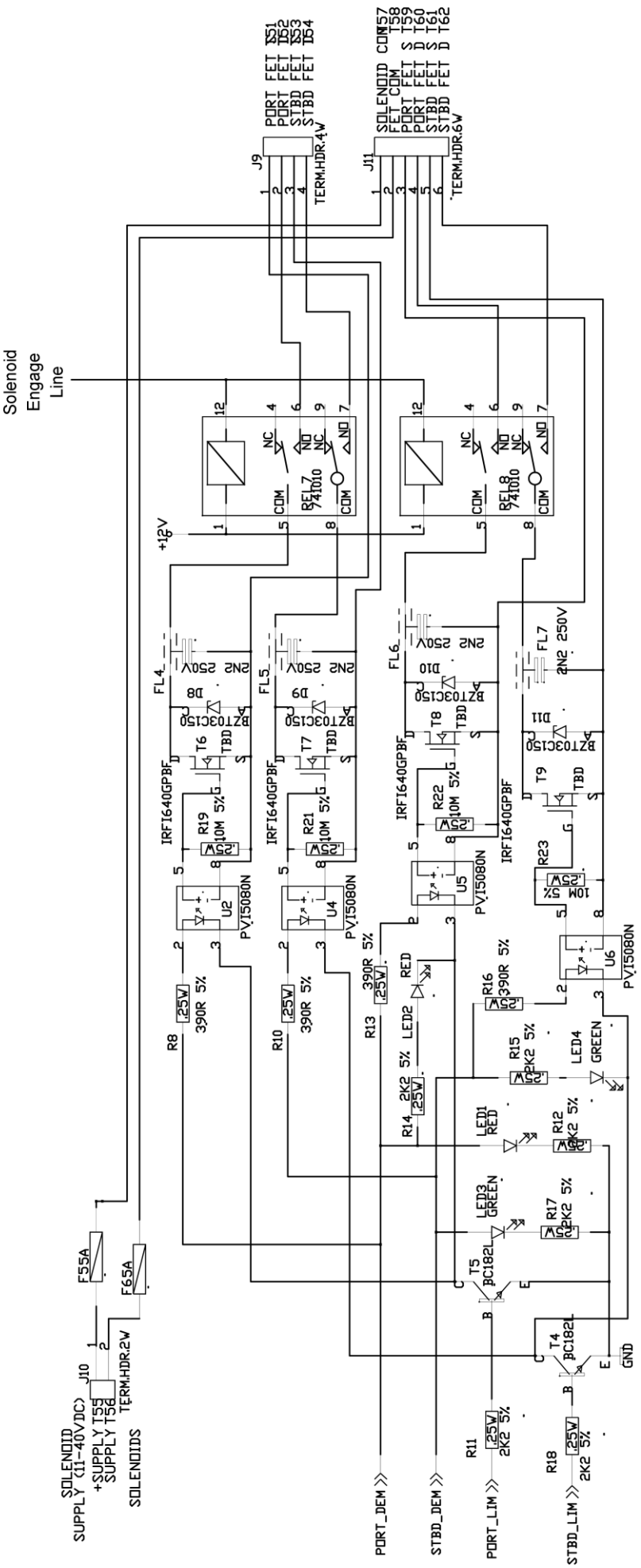


FIG TM3.1.3 Solenoid Output Configuration

TM3.2: The Rudder Reference (Feedback) Potentiometer (Continued).

Where a conventional Rudder Reference Unit with conventional geometry is employed, this can be calculated as follows: -

$$\frac{\text{Pot End Voltage}}{\text{Pot Track Angle}} \quad X \quad \frac{\text{Rudder Arm Length (Y)}}{\text{Ref Unit Arm Length (X)}}$$

(See FIG TM3.2 for arm lengths X and Y)

N.B. Where a non-standard Rudder Ref. Unit is employed, the ratio of angular movement(Rudder: Pot shaft) must be substituted for arm lengths X and Y.

Example 1:

A standard Autopilot Installation complete with Navitron Rudder Ref. Unit with a coupling ratio (X:Y) of 1.5:1

$$= \frac{\text{Pot End Voltage (5V)}}{\text{Track Angle (100°)}} \quad X \quad \frac{\text{Rudder Arm Length (1.0)}}{\text{Ref. Arm Length (1.5)}} = 33.33\text{mV/°}$$

Example 2:

A standard NT888G series Control Unit & Distribution Unit installed to a 2:1 reduction, gear driven alternative potentiometer shaft and based on the following assumptions: -

Coupling (gear) ratio (rudder: pot shaft) = 2:1
Pot track angle 270°

$$= \frac{\text{Pot End Voltage (5V)}}{\text{Track Angle (270°)}} \quad X \quad \frac{\text{Pot Shaft Movement 1}}{\text{Rudder Movement 2}} = 9.26\text{mV/°}$$

(Since the figure of 9.26mV/degree falls between the limits of 7 to 65mV/degree, the application is viable).

Compatible solutions are generally available for potentiometer values between 500 ohms - 5K ohms and track angles of 80° - 330°. If in doubt consult Navitron Systems Ltd.

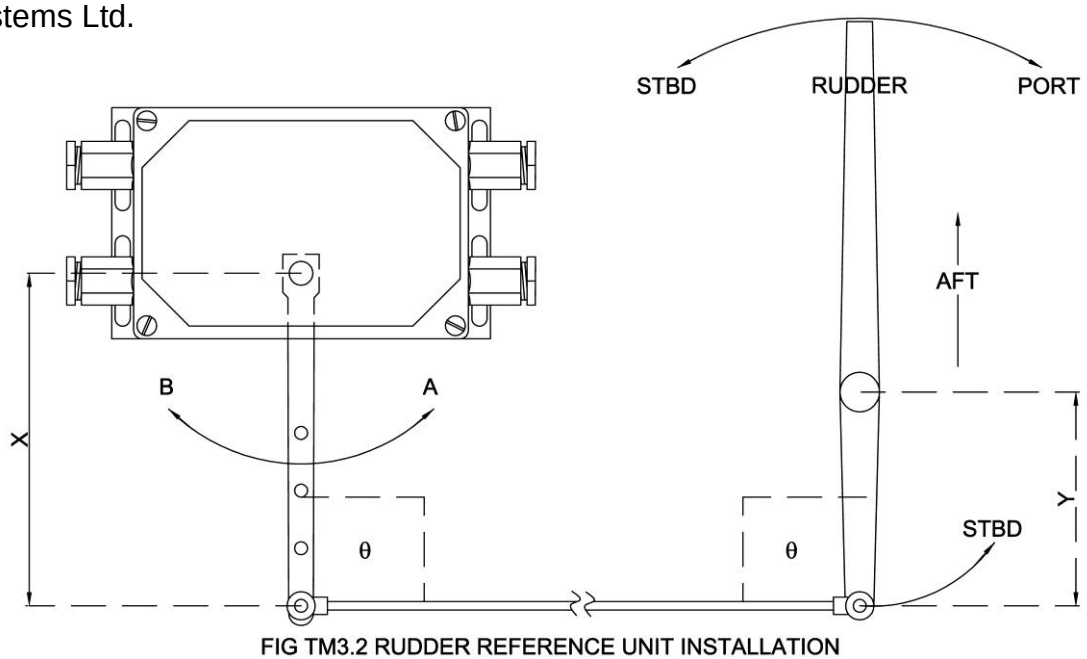


FIG TM3.2 RUDDER REFERENCE UNIT INSTALLATION

N.B. The relative arm lengths of 'X' and 'Y' (the X:Y ratio) should be nominally 1.5:1 and angles θ between arms X and Y and the connecting rod should be 90° when the rudder is amidships.

TM3.3: Analogue Outputs to Steering Machines & Thrusters.

The NT888G Autopilot is equipped with dual ±10Vdc and 4-20mA analogue outputs which can be dedicated to Steering Machine control only (2 x voltage and 2 x current outputs as required) or can be split to provide one pair of outputs (±10Vdc and /or 4-20mA) for Steering Machines/ Rudder control and the remaining pair for control of thrusters.

Galvanically isolated from each other, these two Channels are designated Channel A and B where Channel A is ALWAYS related to Steering machine control, Channel B can be selected via the Set Up Menu for additional Steering Machine control or for Thruster Control only.

Each channel is also equipped to 'request' steering control by signalling the steering control console (if applicable) via volt free relay contacts provided within the Distribution Unit.

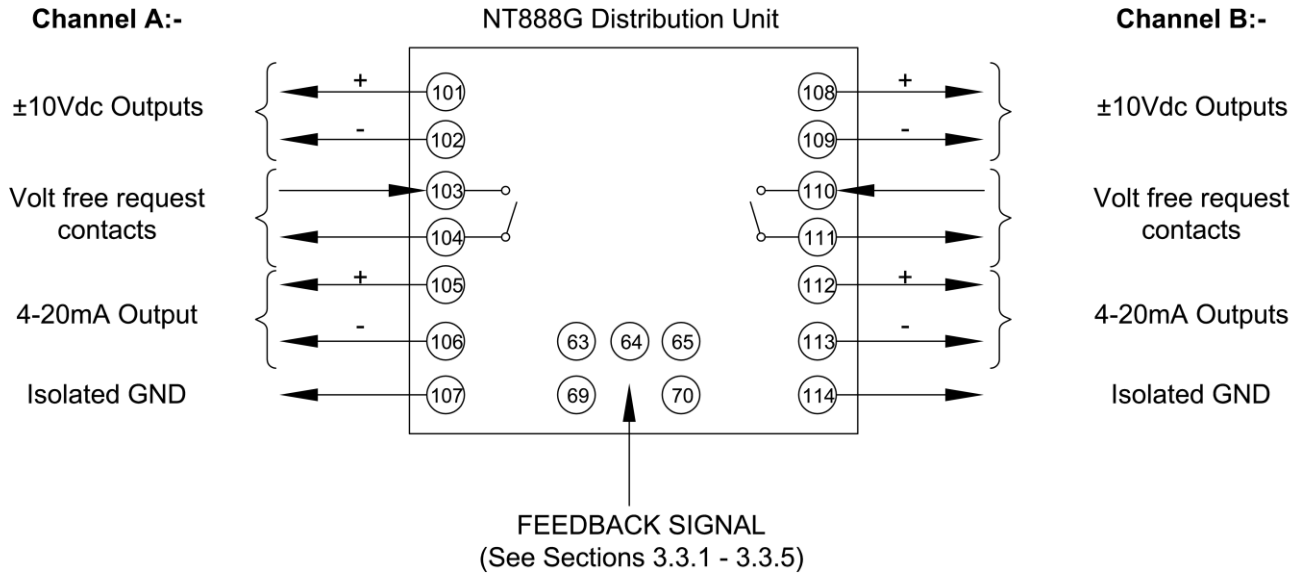


FIG TM3.3

TM3.3.1: Feedback (Rudder Reference Unit) Signals.

The feedback terminals provided within the NT888G Distribution Unit access an isolated input stage which will accept standard Navitron potentiometric signal from a Rudder reference Unit. This input will also accept proprietary Sin/Cos signals (if available) in order that the angular position of the Analogue Steering Machine is continuously monitored by the Autopilot system.

Feedback signal is not always essential.

NB. Demanded position systems can be controlled by the NT888G Autopilot without Feedback but Proportional Error systems **MUST** use a feedback signal since the **'ERROR'** system is dependent on **'closed loop'** operation.

TM3.3.2: Demanded Position versus Proportional Error Systems.

(i) Demanded Position systems typically require a ± calibrated input signal (analogue voltage or current) which produces steering machine movement to an angle corresponding to the value of the input signal (ie. ±5Vdc = ±40º thus ±2V = ±16º etc).

This occurs because the proprietary steering system (Schottel, Aquamaster, Roll Royce etc) is equipped with its own internal closed loop feerback which relates directly to the value of the input signal thus demanding a calibrated position.

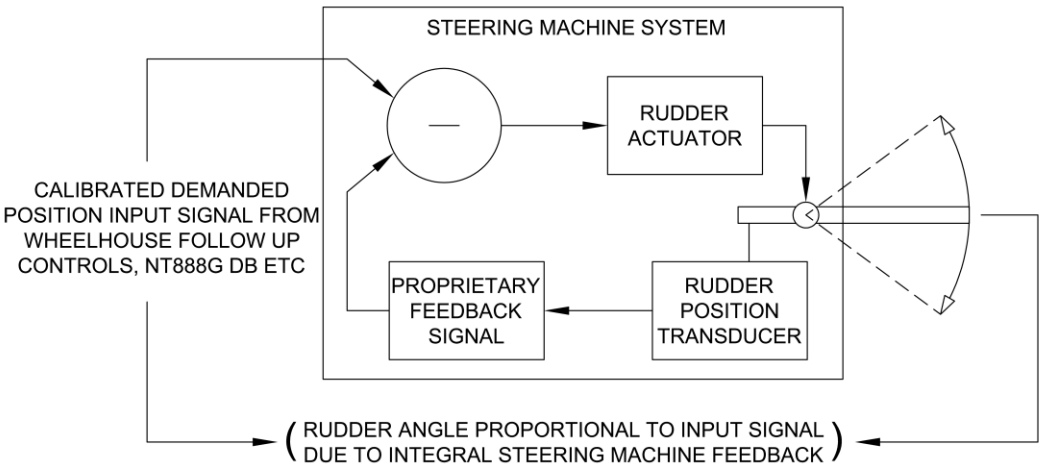


FIG TM3.3.2 (i) - Basic Demanded Position Principle
(Will function with or without dedicated Autopilot feedback)

(ii) Proportional Error Systems are those which are not inherently equipped with feedback (ie. a standard 'bang/bang' solenoid system) and therefore require a mechanically linked (or similar) transducer/Reference Unit to signal the actual position of a rudder etc. Without such feedback, the rudder (or similar) will not be accurately and repeatably positioned and will typically be driven hard over to a mechanical extreme.

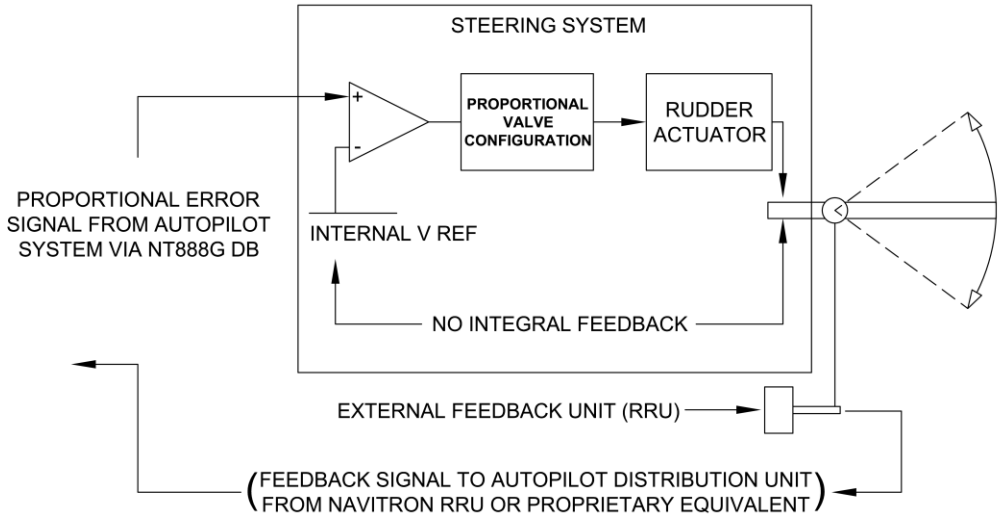


FIG TM3.3.2 (ii) - Basic Proportional Error Principle
(External Rudder Reference Unit essential)

TM3.3.2: Demanded Position versus Proportional Error Systems (Continued).

Demanded Position Systems	-	External Feedback not essential but see Application Note in TM3.3.3.
Proportional Error Systems	-	MUST USE EXTERNAL FEEDBACK.

TM3.3.3: Feedback Application Note.

Feedback Application Note

Provided the Steering System is a Demanded position type (own internal feedback) the Autopilot System will function with or without a steering machine position feedback signal for its own use. However, if no feedback signal is available, the Autopilot Rudder Indicator display will not function and the Automatic Permanent Helm (AUTOTRIM) facility will be partially restricted.

(The Actual steering machine position will be unknown to the Autopilot Control Unit at the instant of Autopilot engagement therefore the AUTOTRIM 'sample and hold' facility will not be available and the steering machine will be moved to the midships – fore and aft position – at commencement of Automatic steering. This will remove any manually determined rudder offset and might result in a temporary change of heading. Initially, this can be mitigated by single press action of the AUTOTRIM key to accelerate rudder offset calculation and, ultimately, any steering machine offset angle required to steer the vessel dead ahead on the specified course will still be calculated and automatically adjusted by the Autopilot AUTOTRIM circuitry over a period of time following initial engagement)

NB. Where practicable, it is always better to provide steering machine position feedback for the Autopilot System.

A special display mode can be selected when the Autopilot is used without continuous rudder position feedback to show DEMANDED instead of ACTUAL angle. The Port & Stbd chevrons will also indicate changes in angle ordered. This mode requires that solenoids are disabled with both limit switches open circuit. (DB terminals 64 & 65 on Fig. 2.1.2 & Set Up parameter 16 in Sect. 3.4).

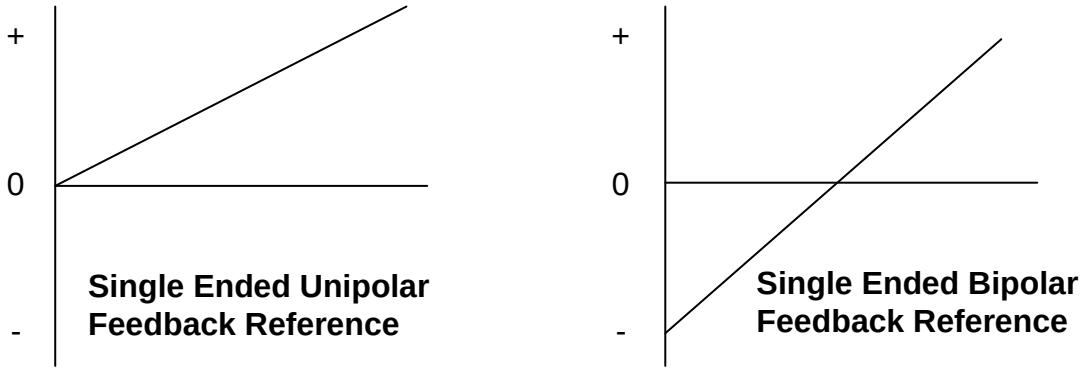
TM3.3.4: Feedback Options.

Any Analogue steering system inherently capable of follow up operation will normally be a closed loop system containing a feedback reference signal which is continuously compared with the Bridge/Wheelhouse positional demands.

The feedback signal type will normally be of the Sin/Cos or single ended (variable dc from potentiometer) type (see Fig TM3.3.4 (i)).

Fully isolated feedback input stages are available within the NT888G Distribution Unit to accept Sin/Cos or single ended signals extracted from the steering machine follow up system (Term N°s 63-70 refer).

If no suitable proprietary feedback signal extraction is possible, consideration should be given to a standard Navitron Rudder Reference Unit mechanically coupled to the steering machine to provide feedback information directly to the Distribution Unit. (See Fig. TM3.3).



NB. Feedback voltage Ranges are ± 5v or ±15Vdc and are Link selectable (FIG TM3.3.4 (ii)) within the NT888G Distribution Unit.

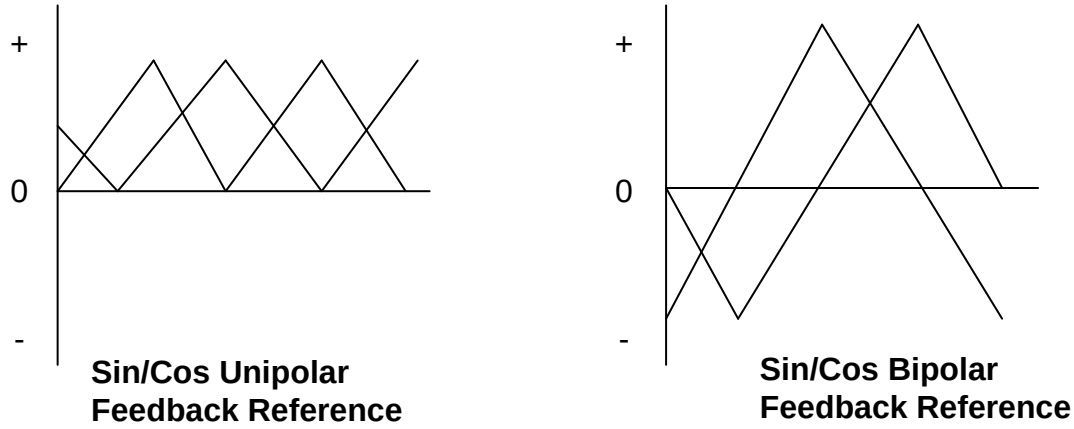
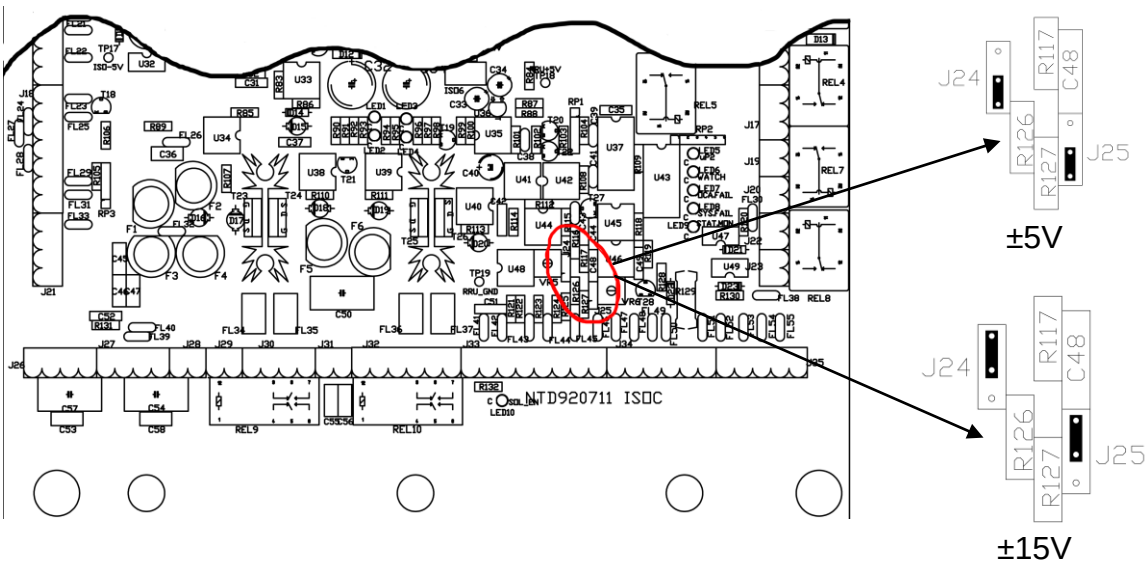


FIG TM3.3.4 (i) – Feedback Signal types accepted by the NT888G.

Note: A single isolated input stage is provided for proprietary rudder feedback signal from both the steering machines. This feedback signal is always directly related to Channel A but, when Channel B is also used for steering machine control (Thruster enable 'OFF') Channel B will operate in sync with Channel A for Demanded Position mode.



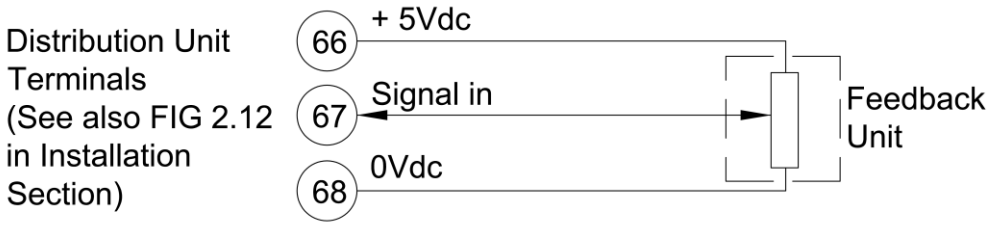
NT888G DU CONNECTOR BOARD

FIG TM3.3.4 (i)

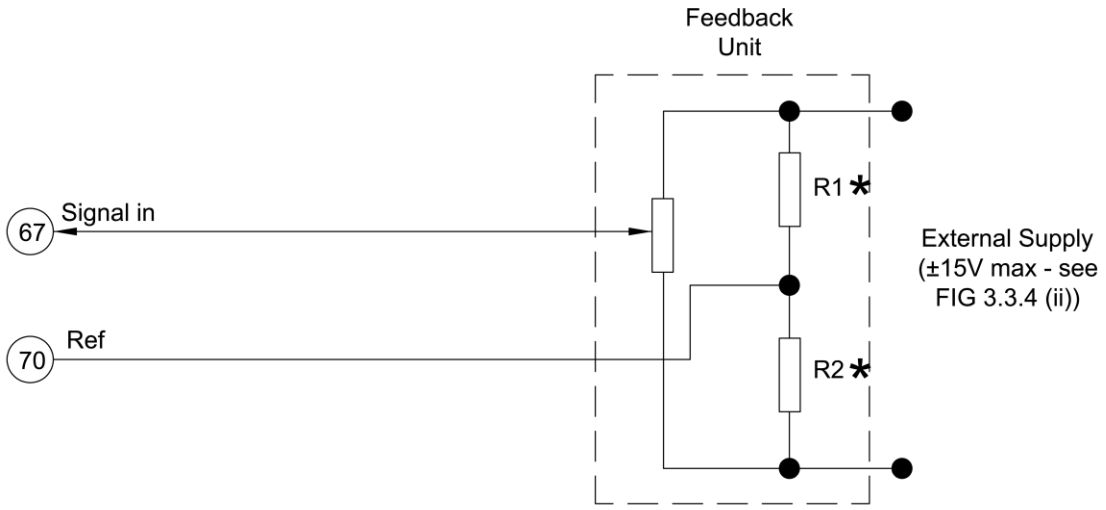
TM3.3.5: Feedback Connections.

Feedback signal (when used) is connected to the Distribution Unit as conventional potentiometer or as a Sin/Cos input.

(i) Conventional (monopolar) Potentiometer (Includes Navitron Type(s)).



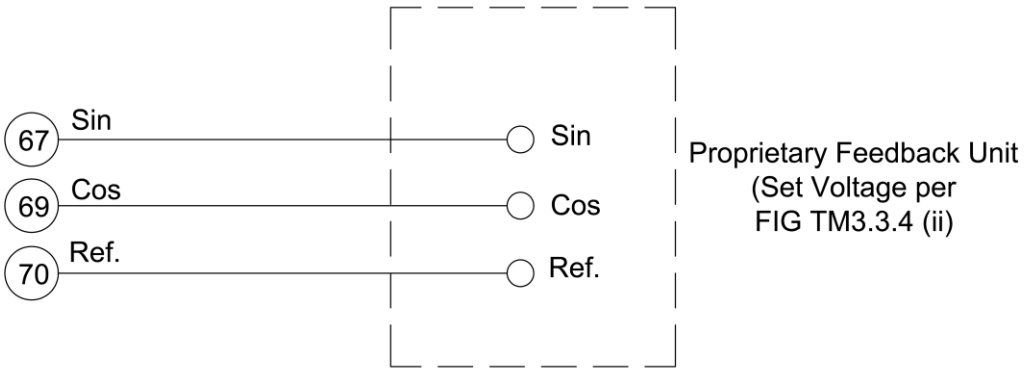
(ii) Conventional (Bipolar) Potentiometer.



* RESISTORS R1 & R2 CONNECTED ACROSS POT SUPPLY TO PROVIDE CENTRE POINT FOR ± FEEDBACK SIGNALS:-

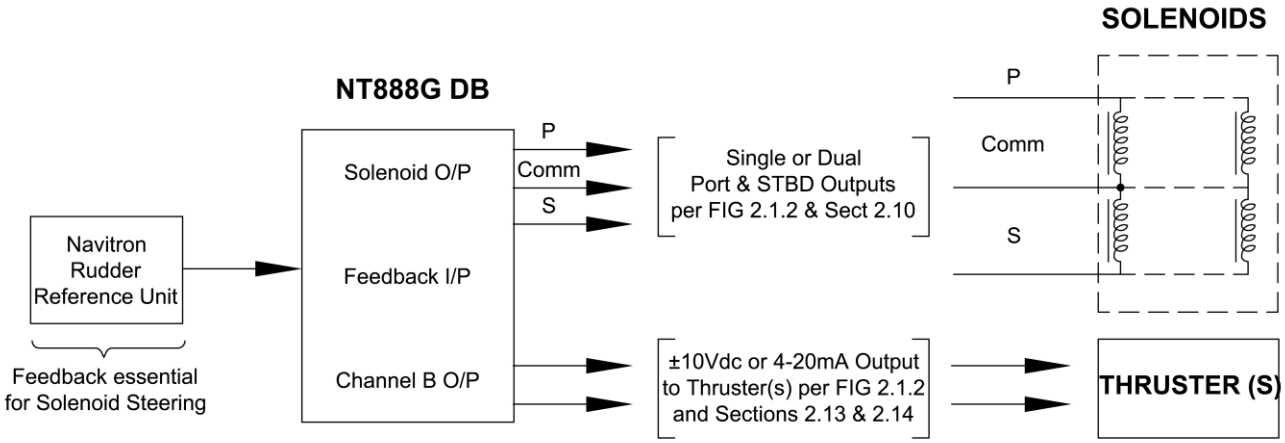
R1 & R2 Values (0.5W)	±5V	±10V	±15V
	470 Ω	1K Ω	1.5K Ω

(iii) Sin/Cos Potentiometer.



TM3.3.6: Steering System Configurations.

(i) Standard Solenoid and Thruster Control.



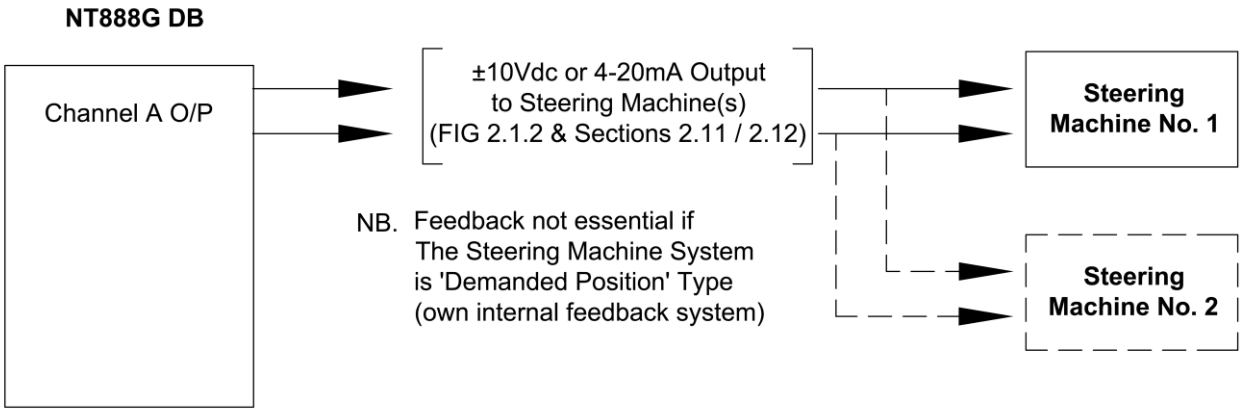
(a) Operational:- Modes
Rudder Control (via solenoids) when selected.
Thruster Control (via Chan. B) when selected.
Rudder & Thruster (solenoids & Ch.B) when selected.

(b) Cables: - 16 and 17 (if applicable) 18 and 29 per FIG 2.1.1.

(c) Connections: - FIG 2.1.2, Sections 2.9, 2.10, 2.13 & 2.14.

(d) Set Up: - Parameters		
	Displacement or HSC Mode Selection	Section 3.9.
	Thruster Enable to 'ON'	Section 3.14.
	Solenoids Enable 'ON'	Section 3.20.
	Limit Switch & relevant Set Up	Section 3.

(ii) Analogue Steering Machine(s) using One (Channel A) Output.



(a) Operational: - Modes
Rudder Control only (via Steering Machine(s)).

(b) Cables: - 29 per FIG 2.1.1.

(c) Connections: - FIG 2.1.2 & Sections 2.13 / 2.14.

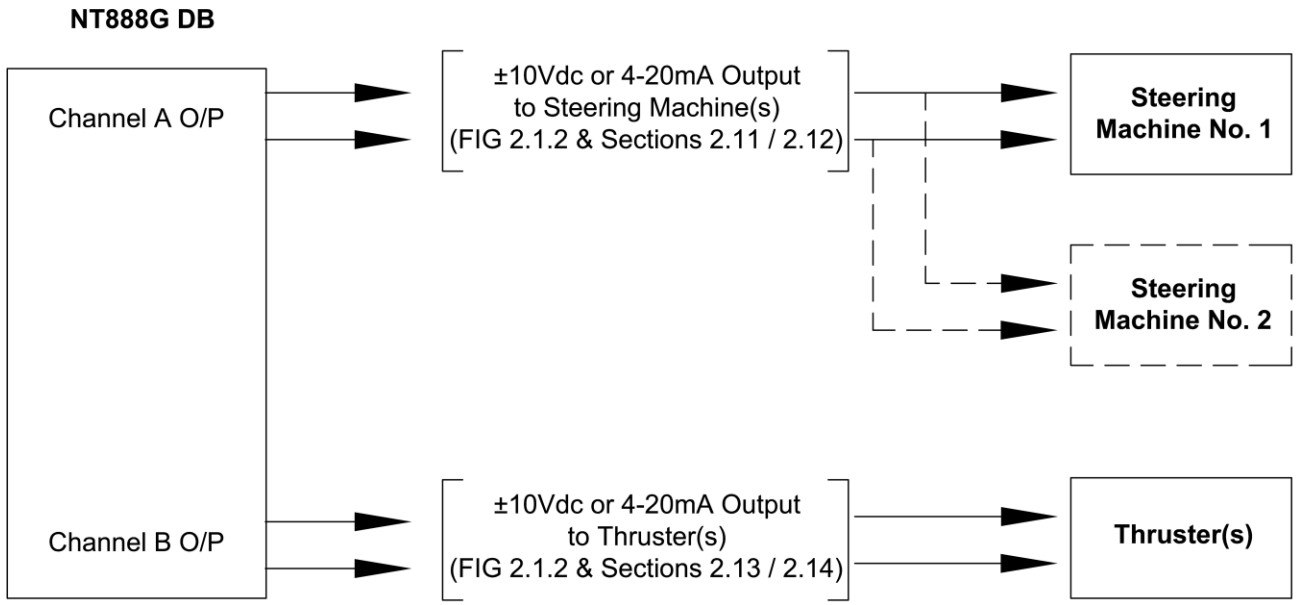
(d) Set Up:- Parameters		
	Displacement or HSC Mode Selection	Section 3.9.
	Solenoid Enable 'OFF'	Section 3.20.
	Channel 'A' mode to 'POSITION'	Section 3.55.
	±10Vdc Outputs	Sections 3.56 & 3.57.

TM3.3.6 (ii): Analogue Steering Machine(s) using One (Channel A) Output (Cont.).

4-20mA Outputs	Sections 3.58 & 3.59.

See also Sections 3.28 to 3.30 and set if/as applicable.

(iii) Analogue Steering Machines(s) and Thruster(s).



NB. Feedback not essential if the Steering Machine system is Demanded Position Type (own internal feedback system)

(a) Operational:- Modes
Rudder Control only (via steering machines) when selected.
Thruster Control only (via Chan. B) when selected.
Steer Mach + Thruster (Ch A & Ch.B) when selected.

(b) Cables: - 28 and 29 per FIG 2.1.1.

(c) Connections: - FIG 2.1.2, Sections 2.11, 2.12, 2.13 & 2.14.

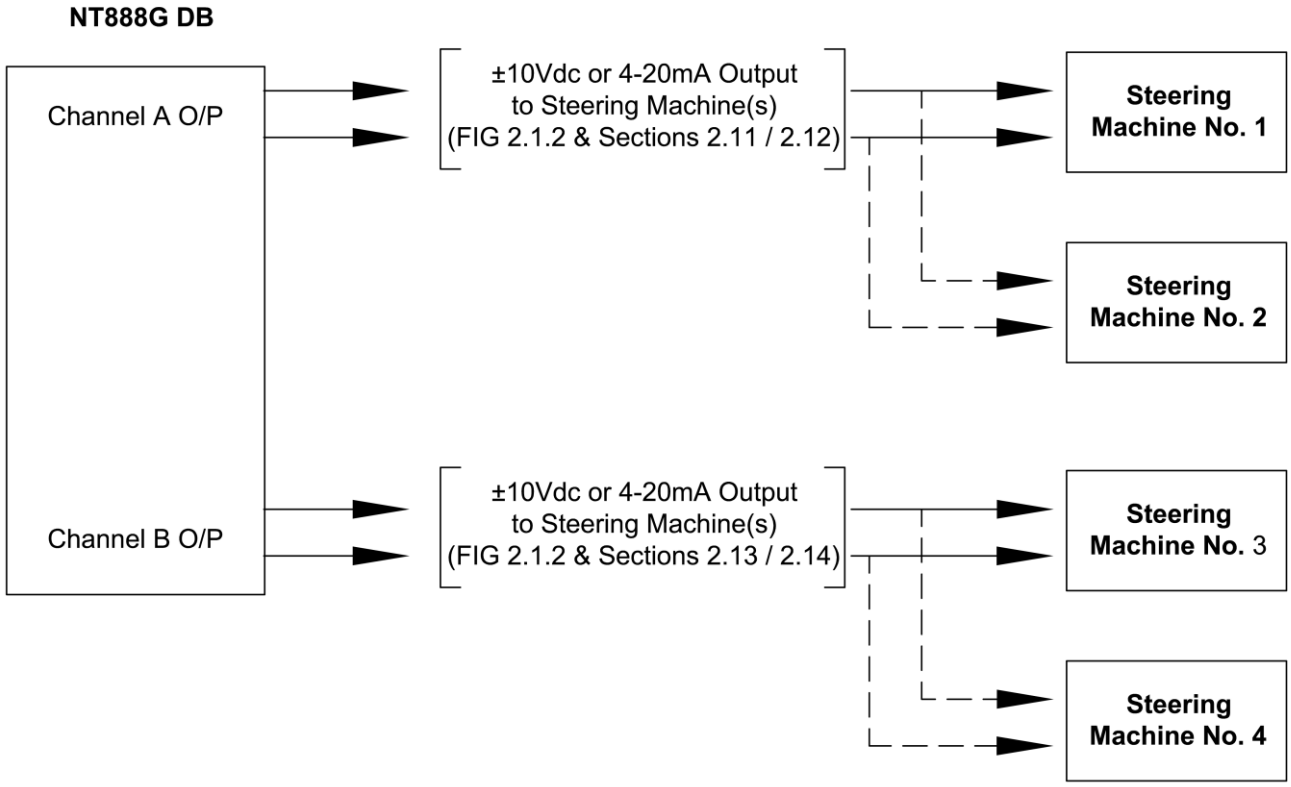
(d) Set Up: - Parameters

Displacement or HSC Mode Selection	Section 3.9.
Thruster Enable to 'ON'	Section 3.14.
Solenoids Enable to 'OFF'	Section 3.20.
Channel A to 'POSITION'	Section 3.55.
Channel A Output Cal.	Sections 3.56 & 3.57.
or	
Channel A 4-20mA (if applicable)	Sections 3.58 & 3.59.
Channel B Output Cal (±10V)	Sections 3.60 & 3.61.
or	
Channel B 4-20mA (if applicable)	Sections 3.62 & 3.63.

See also Sections 3.28 to 3.30 and set if/as applicable.

TM3.3.6: Steering System Configurations (Continued).

(iv) Analogue Steering Machines only on Channel A and Channel B.



NB. Feedback not essential if the Steering Machine system is Demanded Position Type (own internal feedback system)

(a) Operational:- Modes — Rudder Control only (via all steering machines or machines as selected by external selector switch) see FIG TM3.3.6.

(b) Cables: - 28 and 29 per FIG 2.1.1.

(c) Connections: - FIG 2.1.2, Sections 2.13 & 2.14.

(d) Set Up: - Parameters

Displacement or HSC Mode Selection	Section 3.9.
Thruster Enable to 'OFF'	Section 3.14.
Solenoids Enable to 'OFF'	Section 3.20.
Channel A to 'POSITION'	Section 3.55.
Channel A Voltage (±10Vdc)	Sections 3.56 & 3.57.
or	
Channel A Current (4-20mA)	Sections 3.58 & 3.59.
Channel B Voltage (±10Vdc)	Sections 3.60 & 3.61.
or	
Channel B Current (4-20mA)	Sections 3.62 & 3.63.

See also Sections 3.28 to 3.30 and set if/as applicable.

TM3.3.6 (iv): Analogue Steering Machines only on Ch A and Ch B. (Continued)

Selective Steering machines Control could be achieved in a number of ways and an example is shown in FIG TM3.3.6 which makes use of the relay contact closures associated with channels A and B when their outputs are active.

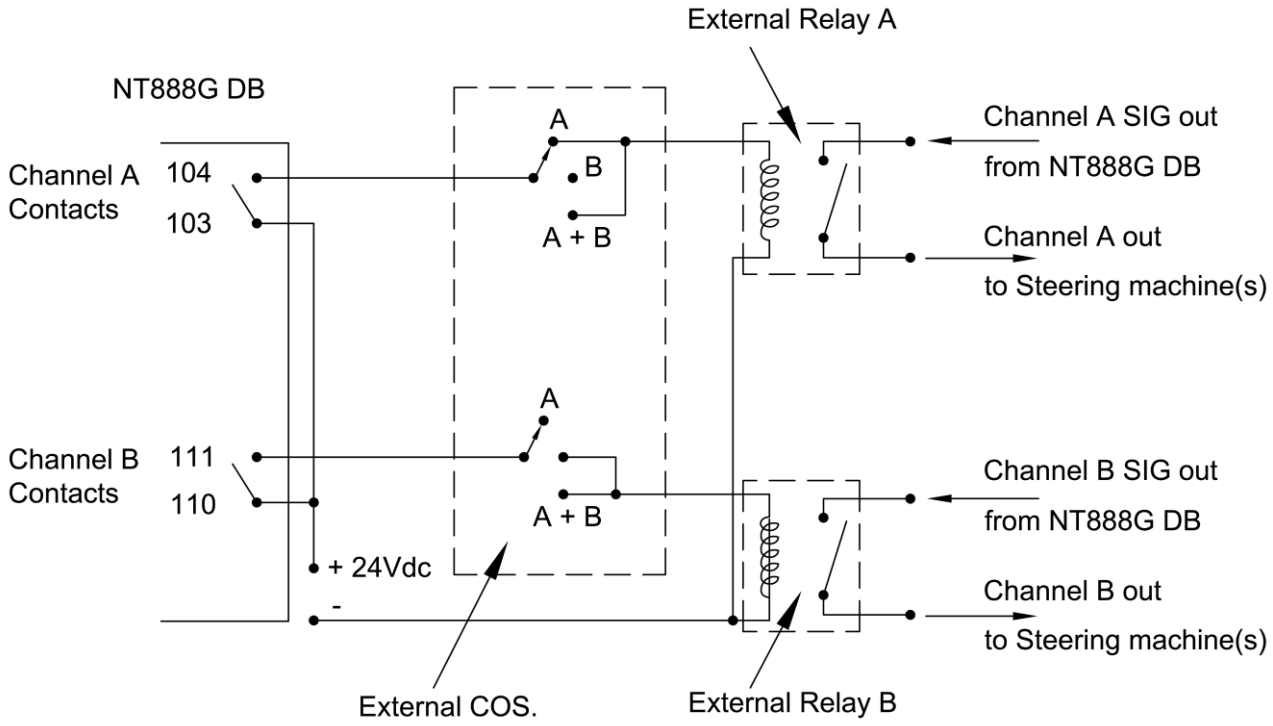


FIG TM3.3.6
Selective Steering Machine Control.

TM3.4: Proprietary Remote Power Steer Connections.

All Navitron Autopilots are internally equipped to accept both Follow Up and Non Follow Up signal inputs from virtually any type of potentiometric (Follow Up) or Jog Switch (Non Follow Up) remote station. Facilities are also included for remote 'Dodge' operation.

TM3.4.1: Full Follow Up and Non Follow Up Operating Conditions.

Follow Up (FU) and Non Follow Up (NFU) steering is available when the Autopilot is engaged (ON) and the REMOTE key is activated (corner LED illuminated): -

Autopilot Mode Switch Position	Remote Power Steer Operation Available
OFF	NONE
STANDBY	NONE
ON	NONE
ON + REMOTE key	Power Steering (Autopilot Override) Available when Remote Station ON/OFF Switch Set to ON.
Track	As 'Remote' plus Track Steering operational

A remote power steer 'ON' condition is confirmed at the Autopilot Control Unit by the display message **'REMOTE FU STEERING', 'REMOTE NFU STEERING' or 'REMOTE DODGE STEERING'** accompanied by an audible bleep at regular 10 second intervals to signify that an Autopilot override conditions exists.

NB. The audible bleep can be permanently silenced via the Set Up mode if not required (See installation section 3.4 parameter No.49).

It is important to note that when a Remote Steer Station is operational (ON) the Autopilot ceases to make automatic heading corrections reverting instead to the 'STANDBY' condition which enables the Autopilot to 'Track' any change in ships heading as a result of FU or NFU Remote station demands. This allows PERMANENT Course alteration to be made from a Power Steer station since the autopilot will automatically resume control of the vessel and maintain whatever new heading prevails when the Remote Power Steer Station is switched 'OFF'.

TM3.4.2: Non Follow Up Mode (FIG TM3.4.2 refers).

In this mode, rudder will continue to be applied at all times that the remote tiller is in the Port or Starboard position and will only stop when the tiller is centralised. Whilst the value of R1 will not affect the rudder angle applied, a value of 10K ohms should still be inserted to prevent short circuit paths arising from simultaneous operation (in opposite directions) of multi station systems.

TM3.4.3: Full Follow Up Mode (FIG 3.4.3 refers).

In this steering mode, Automatic Permanent Helm (AUTOTRIM) is cancelled thus the maximum angle of rudder (+/- 30° etc.) will be relative to midships rudder.

NB. The value of Resistor R1 will determine the maximum angle of rudder that will be applied by the Remote station in the Follow Up and Dodge modes in accordance with Table A.

+/- Max Rudder Angle	35°	30°	25°	20°	15°	10°	5°
R1 (ohms)	51K	75K	100K	150K	200K	330K	750K

Table A.

TM3.4.4: Dodge Operation (FIG TM3.4.4 refers).

Remote Dodge operation is available when the Autopilot is engaged (ON) and the 'REMOTE' key is activated (corner LED on). Dodge operation is also available in the Track Steering mode.

The 'ON' condition is confirmed at the Autopilot Control Unit by the display message **'REMOTE DODGE STEERING'** and is accompanied by an audible 'bleep' at regular 10 second intervals to signify that an Autopilot override condition exists.

Remote station Dodge demands will result in Follow Up or fixed rudder angle application (R1 refers) to produce TEMPORARY course change since, when the remote station is switched 'OFF', the ships head will automatically be turned to the original Autopilot course.

Since the 'DODGE' mode is associated with temporary course change, any previously determined angle of rudder attributable to Automatic Permanent Helm (AUTOTRIM) is retained thus the maximum angle of rudder applied via the Dodge station will be relative to (i.e. will add to or subtract from) the AUTOTRIM rudder offset angle.

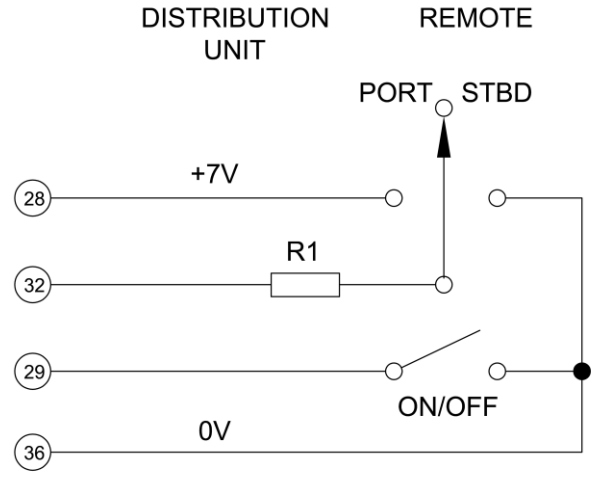


FIG TM3.4.2 Non Follow Up Remote Steer Connections.

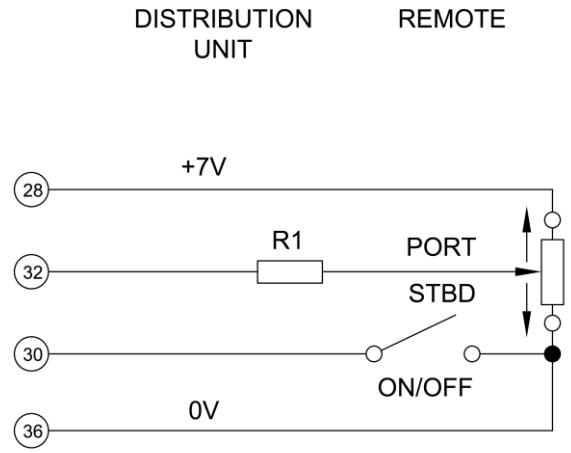


FIG TM3.4.3 Full Follow Up Remote Steer Connections.

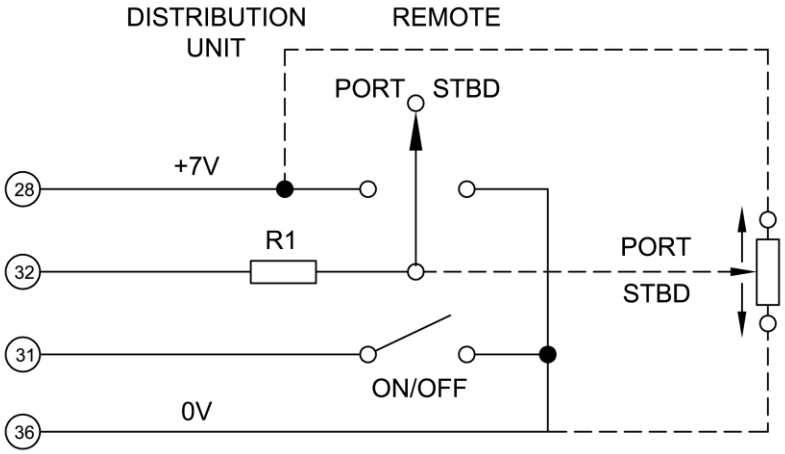


FIG TM3.4.4 Dodge Mode Remote Steer Connections.

Refer to table A for R1 values.

TM3.5: Proprietary Follow Up Wheel And Override Power Steer.

The Distribution unit is equipped with an isolated input facility and will accept an analogue Follow Up Wheel steering signal (± 10Vdc) maximum, or, a Non Follow Up Jog lever input which can be programmed as a Latched or Non Latched Autopilot override control.

(Operating notes in Section 2.43 of the Operating Manual).

The Distribution Unit terminal services are arranged as follows:-

22 + \
23 - } Opto Isolated input (10 - 40Vdc) to request/accept external Follow Up signal (not required for NFU Override function).

24 + 5Vdc Supply out.

25 Signal Input Line (wiper).

26 - 5Vdc Supply.

27 Ground (Isolated input stage).

Accordingly, the Terminal block services provide a 10Vdc supply (10mA source/sink) for connection of a proprietary Follow Up potentiometer which is input active when the opto isolated input terminals (22 & 23) are energized (10 – 40Vdc).

TM3.5 (i): Proprietary Follow Up Power Steer Using Dist. Unit 10Vdc Supply.

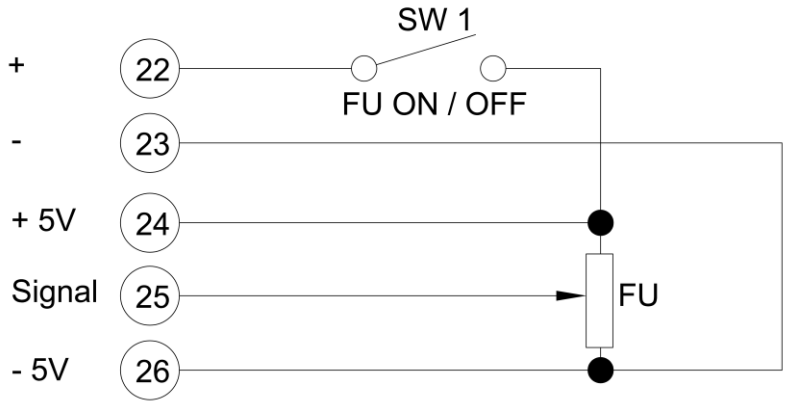


FIG TM3.5 (i)

NB: Follow Up mode selection, angle and direction of applied rudder is calibrated via Sections 3.66 to 3.68 of the NT888G Install and Tech Manual Part 1

TM3.5 (ii): Follow Up External Supply to 10Vdc max.

Provided the external supply voltage range is 2Vdc (min) to 20Vdc (max) the external supply can be connected to 'float' on the Distribution Unit isolated ground terminal:-

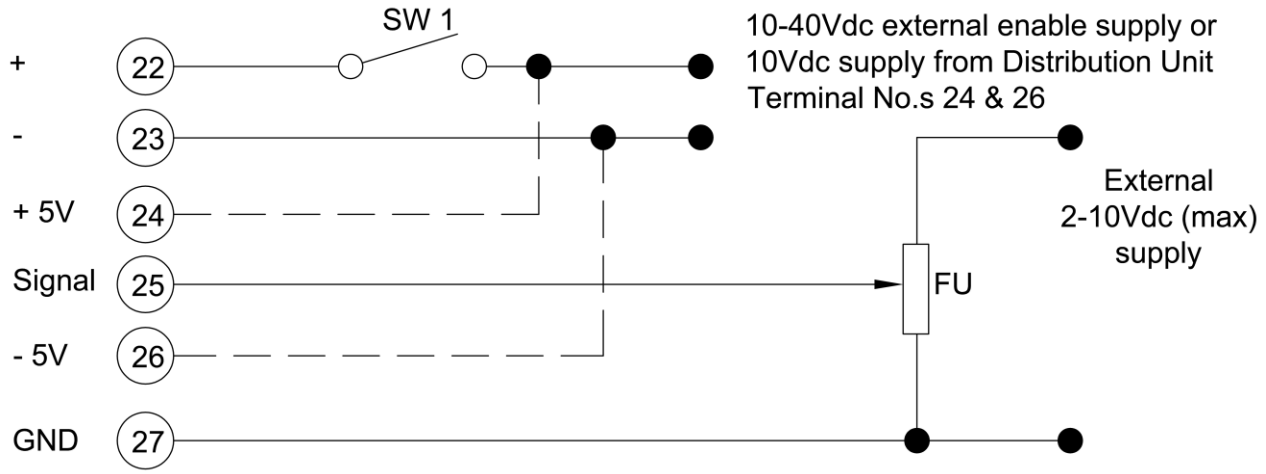
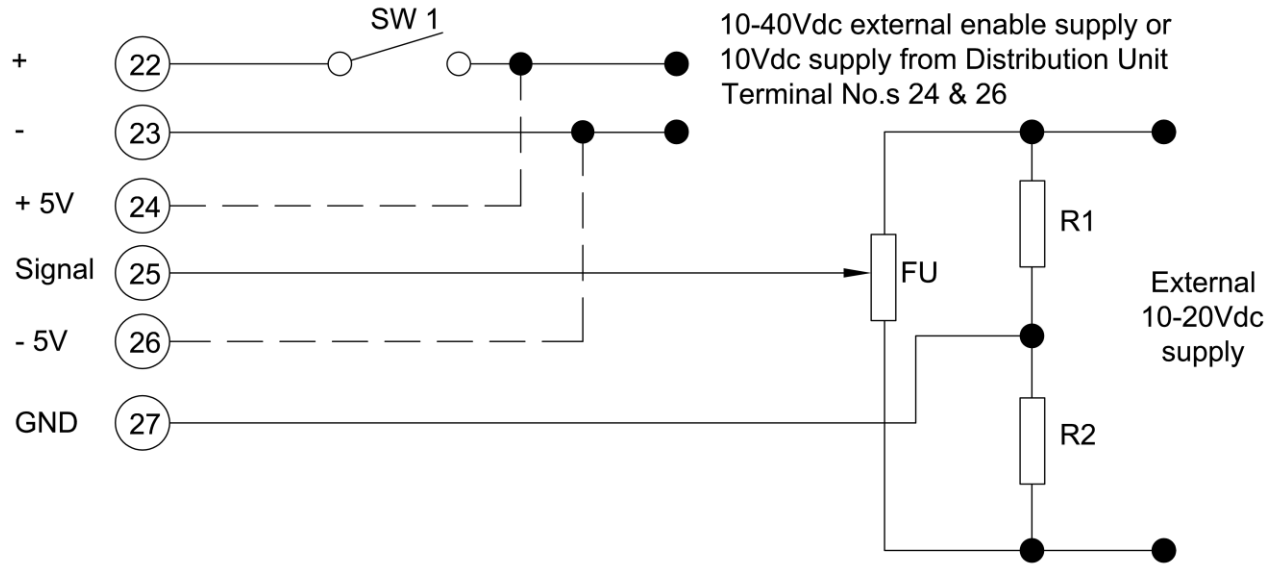


FIG TM3.5 (ii)

TM3.5 (iii): Follow Up External Supply to ±10Vdc (20V max).

External power supplies up to 20Vdc (max) can be connected to provide ±10Vdc signal input via a centre reference point for the GND connection as follows:-

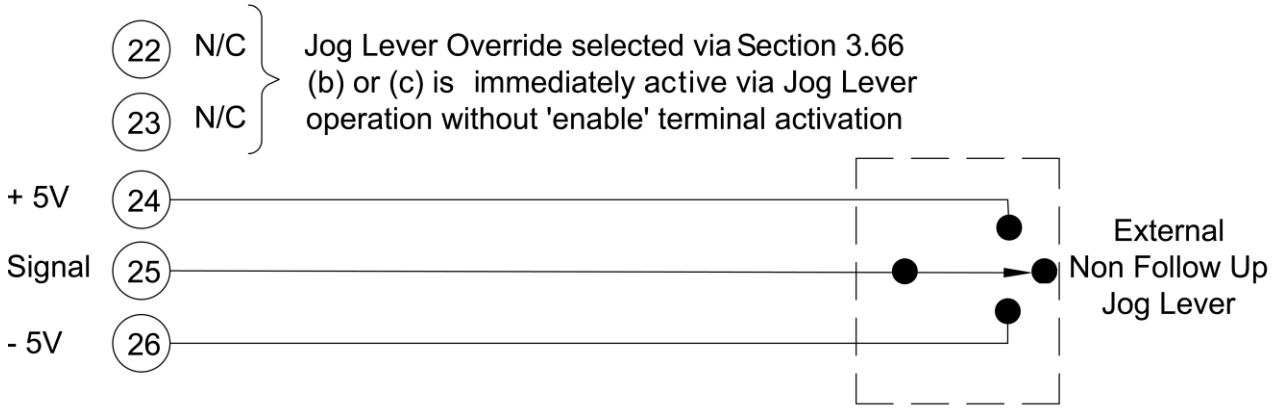


R1 & R2 Values (0.5W)	±2V	±5V	±10V
	100 Ω	470 Ω	1K Ω

FIG TM3.5 (iii)

TM3.5 (iv): Latched & Non Latched Override Connections.

Electrical connections to the Distribution unit are the same for both modes of operation (Latched and Non Latched) which is confined to Non Follow Up jog Levers. (No follow up facility in the override mode).



NB. Maximum Applied rudder angles are calibrated via Section 2.29 of the NT888G Operating Manual.

FIG TM3.5 (iv)
Non Follow Up Override Connections.

TM3.6: Auxiliary Status Alarm Relay Contacts.

Seven sets of Volt free contacts are provided within the Distribution Unit and can be used to activate external alarms or notify Autopilot status as follows:-

TM3.6 (i): Optional Status Contacts (cable No. 25).

A single pole changeover volt free contact is available within the NT888G DB to signal **STANDBY** or ENGAGED (**ON**) mode to remote listeners.

Contact ratings are 3A @ 250Vac.

See FIG 2.1.2 / Terminal N$^{o's}$ 93, 94, 95.

TM3.6 (ii): Optional System Fail Contacts (Cable No. 26).

A single pole, normally open volt free contact within the NT888G DB closes in the event of any failure or warning with the exception of total Power Fail, Off Heading Alarm or Watch Alarm.

This may be used to switch an external alarm unit and the contacts are rated 3A @ 250Vac.

See FIG 2.1.2 / Terminal N$^{o's}$ 96 & 97.

TM3.6 (iii): Optional (Auxiliary) Off Heading Alarm Contacts (Cable No. 24).

A single pole, normally open volt free contact within the NT888G DB closes when the vessel exceeds the specified number of degrees “Off Course” and may be used to switch an external (auxiliary) alarm unit. The contact rating is 3A @250Vac.

See FIG 2.1.2 / Terminal N$^{o's}$ 88 & 89.

TM3.6 (iv): Optional (Auxiliary) Watch Alarm Contacts (Cable No. 22).

A single pole, normally open volt free contact within the NT888G DB closes when the Watch Alarm time out period (3 to 12 mins.) expires and a further 1 minute elapses beyond which an emergency alarm level may be required. The contact rating is 3A @250Vac.

See FIG 2.1.2 / Terminal N$^{o's}$ 86 & 87.

TM3.6 (v): Optional Power (Fail) Monitor Contacts (Cable No. 23).

A single pole changeover volt free contact is available within the NT888G DB to signal Power Supply Failure to the NT888G Distribution Unit whether or not the Autopilot system is active (**STANDBY** or **ON**).

The normally closed and common contacts may provide a switchline to a central alarm panel if required and are rated 3A @ 250Vac.

See FIG 2.1.2 / Terminal N$^{o's}$ 90, 91, 92.

TM3.6 (vi): Analogue OUTPUT CHANNELS A and B.

Each Analogue output channel (±10Vdc / 4-20mA) is equipped with a volt free single pole normally open contact rated 1A @ 24Vdc which closes when the Autopilot is engaged (ON).

These relays may be used (if required) to request control from a central steering consol etc. and provide closed contacts as follows:-

Channel A – All ‘ON’ modes.
See FIG 2.1.2 / Terminal No.s 103 & 104.

Channel B – Thruster Enable (in Set Up Menu) ON – Thruster mode only.
Thruster Enable (in Set Up Menu) OFF – All ’ON’ modes.
See FIG 2.1.2 / Terminal No.s 110 & 111.

Section TM4: NT888G Distribution Unit Power Distribution.

TM4.1: Main and Secondary Power Supplies.

TM4.2: Main PCB +12V, +7V, +5V & +3.5V Regulation.

TM4.3: Isolated +5V Supply for NMEA CH2 Output Data.

TM4.4: Isolated ±5Vdc Supply for Isolated Steering Input.

TM4.5: Isolated ±13Vdc Supply for CHB Analogue Outputs.

TM4.6: Isolated +5V Supply for Draft Input (4-20mA) Network.

TM4.7: Isolated ±13Vdc Supply for CHA Analogue Outputs.

TM4.8: Isolated +5V Supply for NMEA CH1 Output Data.

TM4.9: Isolated +5V Supply for Rudder Reference Units.

TM4.10: Isolated +5V Supply for Furuno Output Data.

TM4.11: NT888G Main PCB Schematics (NTD920710) Sheets 1 & 4.

TM4.12: NT888G Connector PCB Schematics (NTD920709) Sheets 2 - 6.

TM4.1: Main and Secondary Power Supplies (Drwg NTD920709/2).

The Autopilot System requires two power supplies connected at all times to prevent a power supply failure alarm condition.

Both Main and Secondary power supplies are rated 11-40Vdc, are connected to Distribution Unit terminals 47 & 48 and 49 & 50 respectively and are fused at 2A via fuses F1, F2, F3 & F4 on the Connector PCB.

Zener diodes D15 & D16 provide transient and reverse polarity protection with U33.B acting as the secondary power supply monitor.

T15/T17 network provides low voltage filtering and T14/U33.A provide power up relay excitation (REL3) and primary power monitor.

When the power up relay is energised, the power supply is routed to the Main PCB via 34 way connector J1 (drawing NTD920710 Sheet 1).

TM4.2: Main PCB +12V, +7V, +5V & +3.5V Regulation (Drwg NTD920710/1).

Supply voltage (11-40Vdc) is routed from 34 way connector J1 terminals 29 – 31 (-VE) and 32 – 34 (+VE) to the SMPS voltage regulator (U2) via the filter network C1/L1/C3.

U2 output via flywheel and smoothing network D3/L2/C19 provides **+12Vdc** regulation (which supports following Vreg stages) and can be measured on **Test Point TP1**.

U12 is supplied from the +12V regulated line and provides a **+5V** reg. Output which can be measured on **Test Point TP7**.

U21 is in parallel supplied from the +12V reg. line to provide an output of **+7Vdc** measurable on **Test Point TP9** (factory calibrated via VR1).

The last stage of voltage regulation is via U18.A which provides Vref at **+3.5Vdc** measurable on **Test Point TP2**.

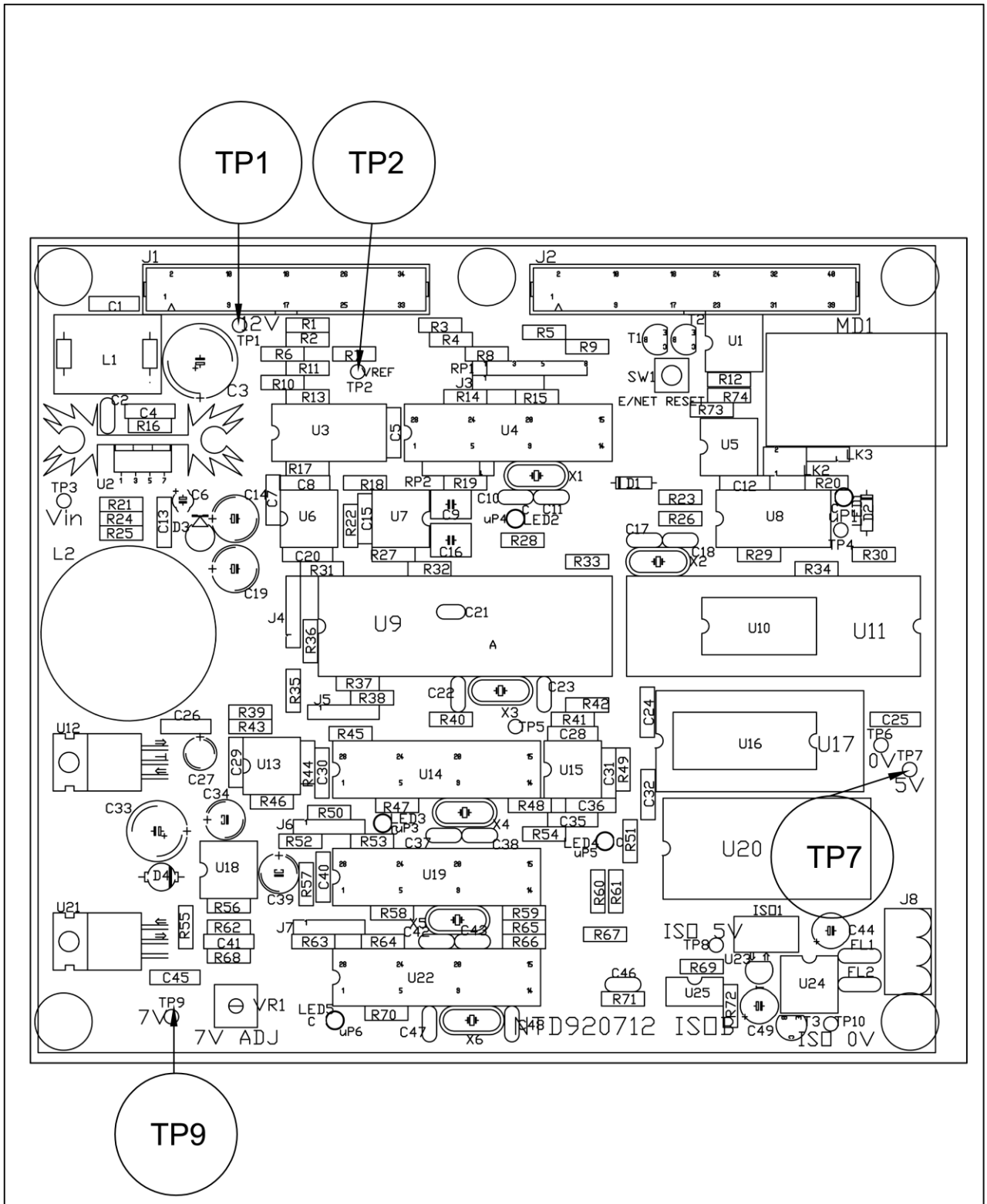
(For Main PCB Test Point locations, refer to drawing NTD920738).

TM4.3: Isolated +5V Supply for NMEA CH2 Output Data (Dwrg NTD920710/4).

ISO1 mounted on the Main PCB is supplied via the +12V regulated line (**TP1** wrt **TP6**). ISO1 output supplies U23 resulting in **+5Vdc** regulation measurable on **Test Point TP8**. (Distribution Unit terminal No.s 119 to 121 refer).

TM4.4: Isolated ±5Vdc Supply for Isolated Steering Input (Dwrg NTD920709/5).

ISO1 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**) and provides ±15V to 5V regulators U18 and U4. U18 output **(+5V**) and U4 output (**-5V**) are measurable on **Test Points TP15** and **TP17** respectively wrt **TP5**. (Distribution Unit terminal No.s 22 to 27 refer).



JOB N°	DRAWN BY	DATE	© COPYRIGHT	
K74	A.J.Z.	13/07/07	NAVITRON SYSTEMS LTD.	
	CHECKED BY	DATE	TITLE: NT888G D/U MAIN pcb Layout	DRAWING NUMBER: NTD920738 / ISO A

TM4.5: Isolated ±13Vdc Supply for CHB Analogue Outputs (Dwrg NTD920709/4).

ISO2 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**) and provides ±15V outputs to regulators U11 and U1.

U11 output is installation adjustable via VR2 from **2 to 26Vdc** and is measurable on **Test Point TP7** wrt **TP21**. This output level (2-26Vdc) is halved by U6.A to provide the Channel B reference point for the Analogue Output (Distribution Unit terminal No.s 108 & 109 refer).

(Conventional maximum Analogue Output for Steering Machines is ±10V but a maximum of ±13Vdc is achievable to cover proportional valves).

U1 output is factory adjusted to provide +24Vdc measurable on **Test Point TP2** wrt **TP21**. and this +24Vdc regulated supply is used for the Channel B 4-20mA output network (U3.A & U3.B/T1 etc.). Distribution unit terminal No.s 112 & 113 refer.

TM4.6: Isolated +5V Supply for Draft Input (4-20mA) Network (Dwg NTD920709/5).

ISO3 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**) and provides an isolated supply for 5V regulator U25 measurable on **Test Point TP11**. (Distribution Unit terminal No.s 20 & 21 refer).

TM4.7: Isolated ±13Vdc Supply for CHA Analogue Outputs (Dwrg NTD920709/4).

ISO4 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**) and provides ±15V outputs to regulators U29 and U15.

U29 output is installation adjustable via VR4 from **2 to 26Vdc** and is measurable on **Test Point TP13** wrt **TP8**. This output level (2-26Vdc) is halved by U22.A to provide the Channel A reference point for the Analogue Output (Distribution Unit terminal No.s 101 & 102 refer).

(Conventional maximum Analogue Output for Steering Machines is ±10V but a maximum of ±13Vdc is achievable to cover proportional valves).

U15 output is factory adjusted to provide +24Vdc measurable on **Test Point TP9** wrt **TP8**. and this +24Vdc regulated supply is used for the Channel A 4-20mA output network (U17.A & U17.B/T7 etc.). Distribution unit terminal No.s 105 & 106 refer.

TM4.8: Isolated +5V Supply for NMEA CH1 Output Data (Dwrg NTD920709/5).

ISO5 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**). ISO1 output supplies U28 resulting in **+5Vdc** regulation measurable on **Test Point TP14**. (Distribution Unit terminal No.s 98 to 100 refer).

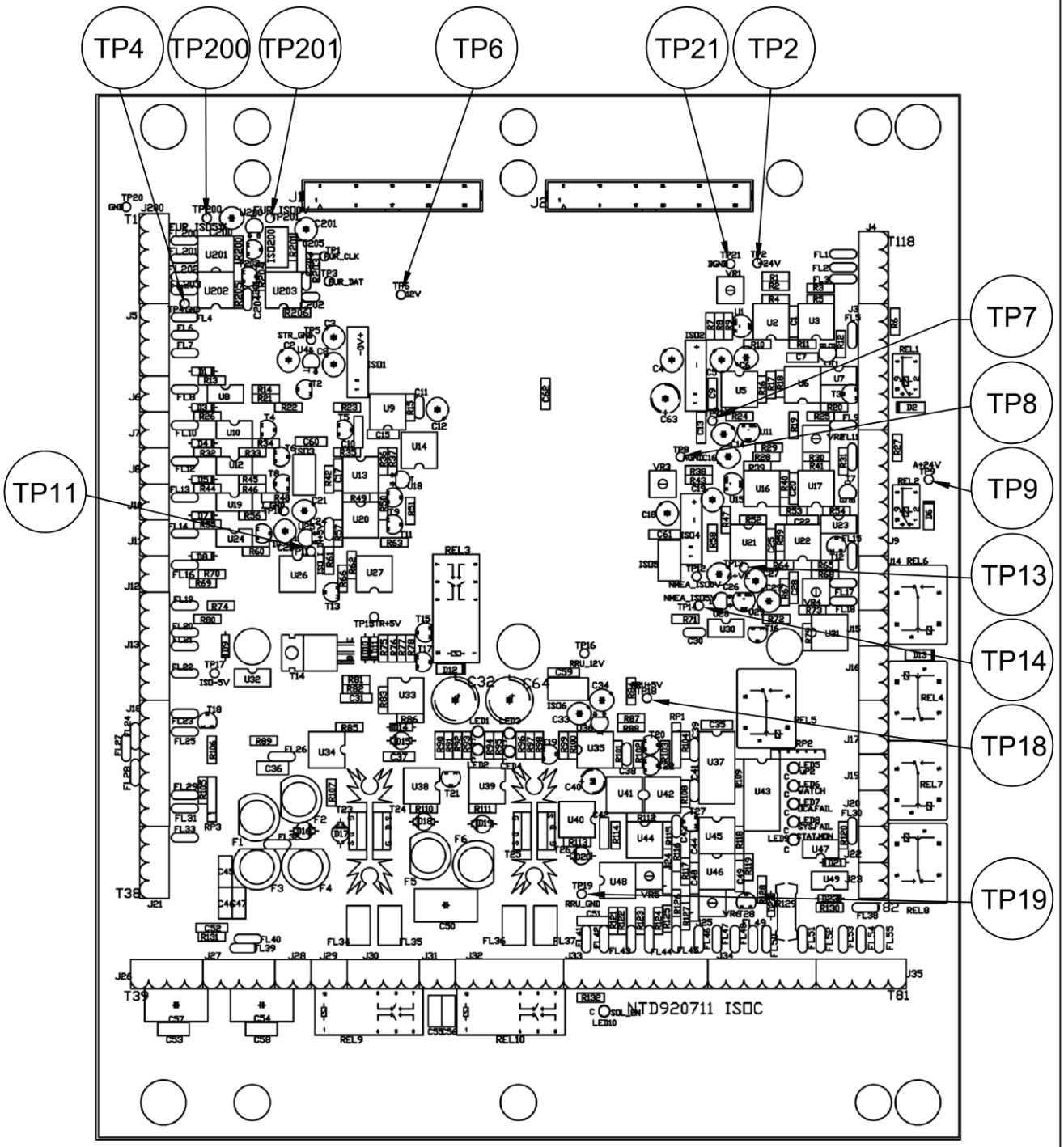
TM4.9: Isolated +5V Supply for Rudder Reference Units (Dwrg NTD920709/3).

ISO6 mounted on the Connector PCB is supplied via the +12V regulated line (**TP6** wrt **TP4**) and provides an isolated supply for 5V regulator U36. The **+5V** regulated output is measurable on **Test Point TP18** wrt **TP19** and is halved by U35.A to produce RRU +2.5V for use by the Feedback network comprising U46.A & U46.B etc. (Distribution Unit terminal No.s 63 to 70 refer).

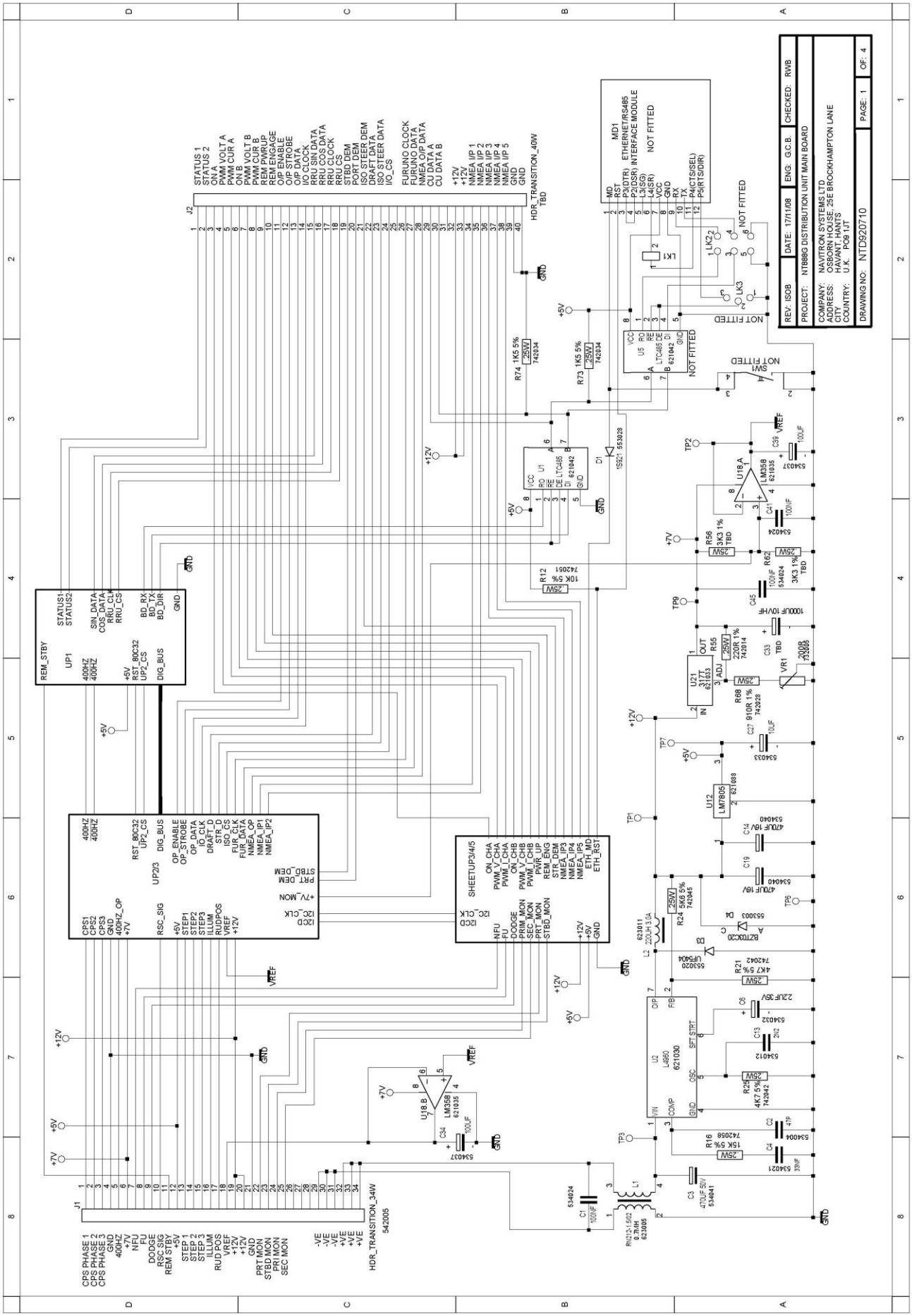
TM4.10: Isolated +5V Supply for Furuno Output Data (Dwrg NTD920709/6).

ISO200 mounted on the Distribution Unit PCB is supplied via the +12V regulated line (Test Point **TP6** wrt **TP4**). ISO200 output provides an isolated supply for 5V regulator U200 measurable at **Test Point TP200** wrt **TP201**. (Distribution Unit terminal No.s 1 to 5 refer).

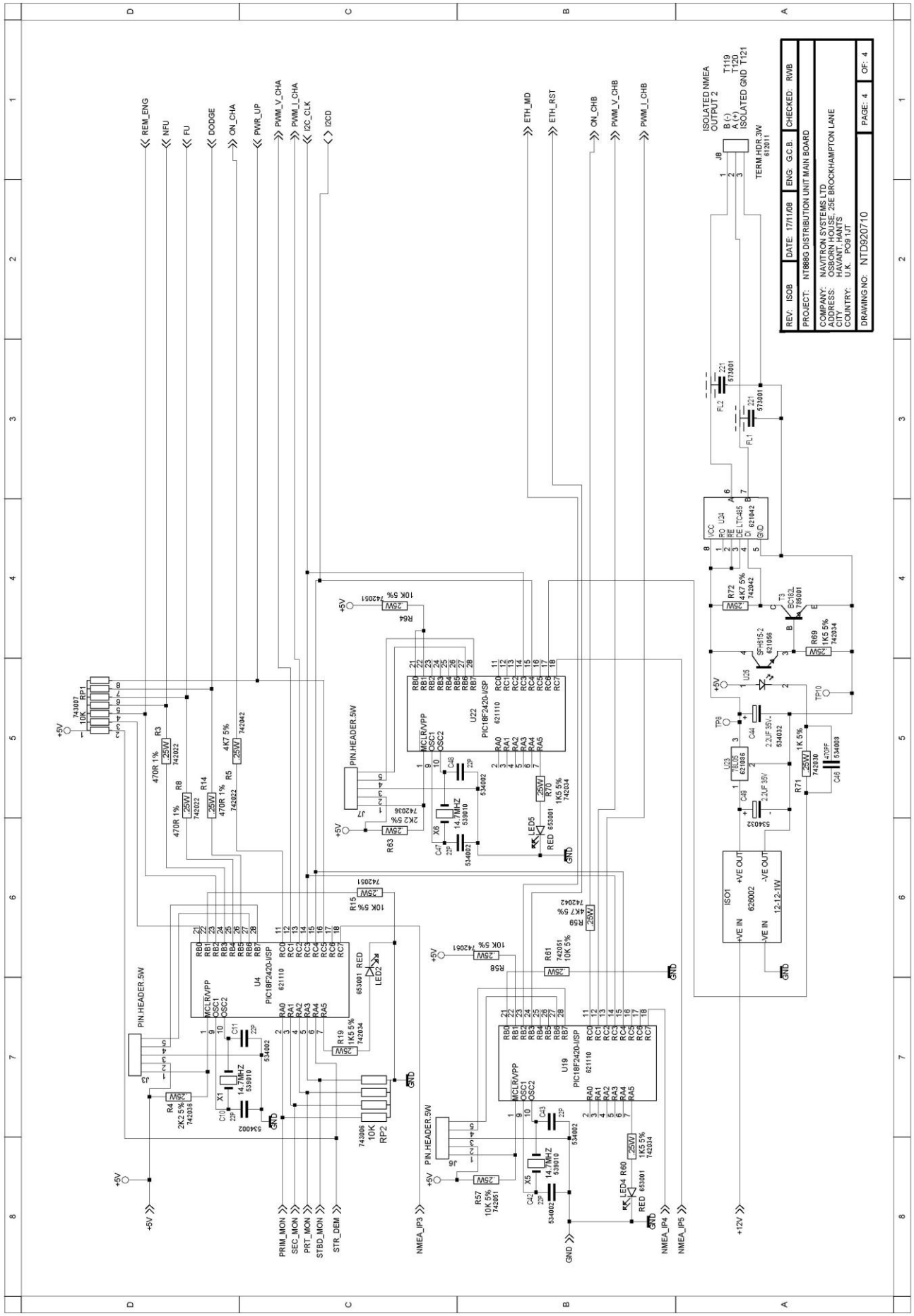
(For Connector PCB Test Point locations, refer to drawing NTD920737).



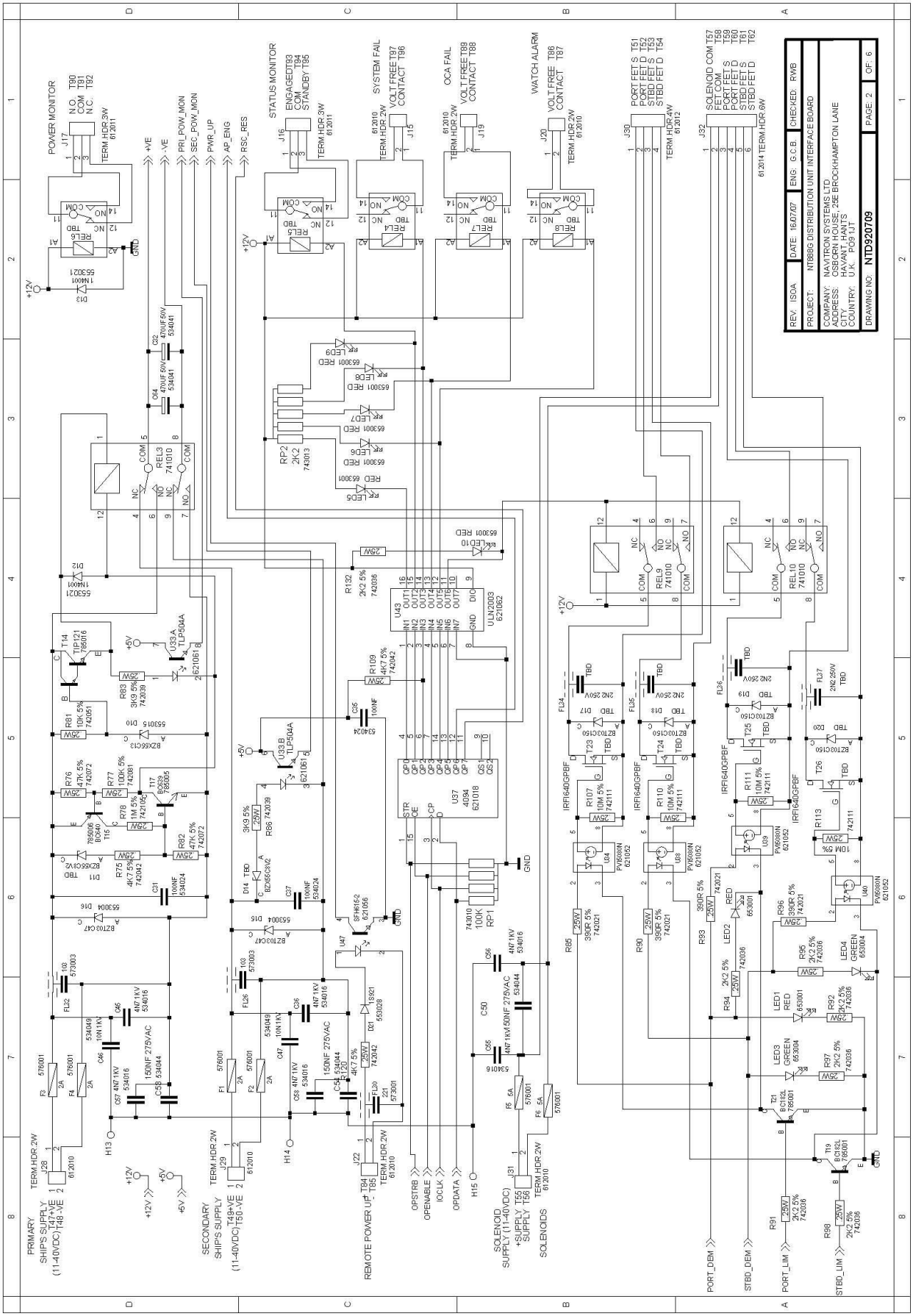
JOB N°	DRAWN BY	DATE	© COPYRIGHT
K73	A.J.Z.	13/07/07	NAVITRON SYSTEMS LTD.
	CHECKED BY	DATE	TITLE: NT888G D/U Connector pcb Layout — DRAWING NUMBER: NTD920737 / ISO A



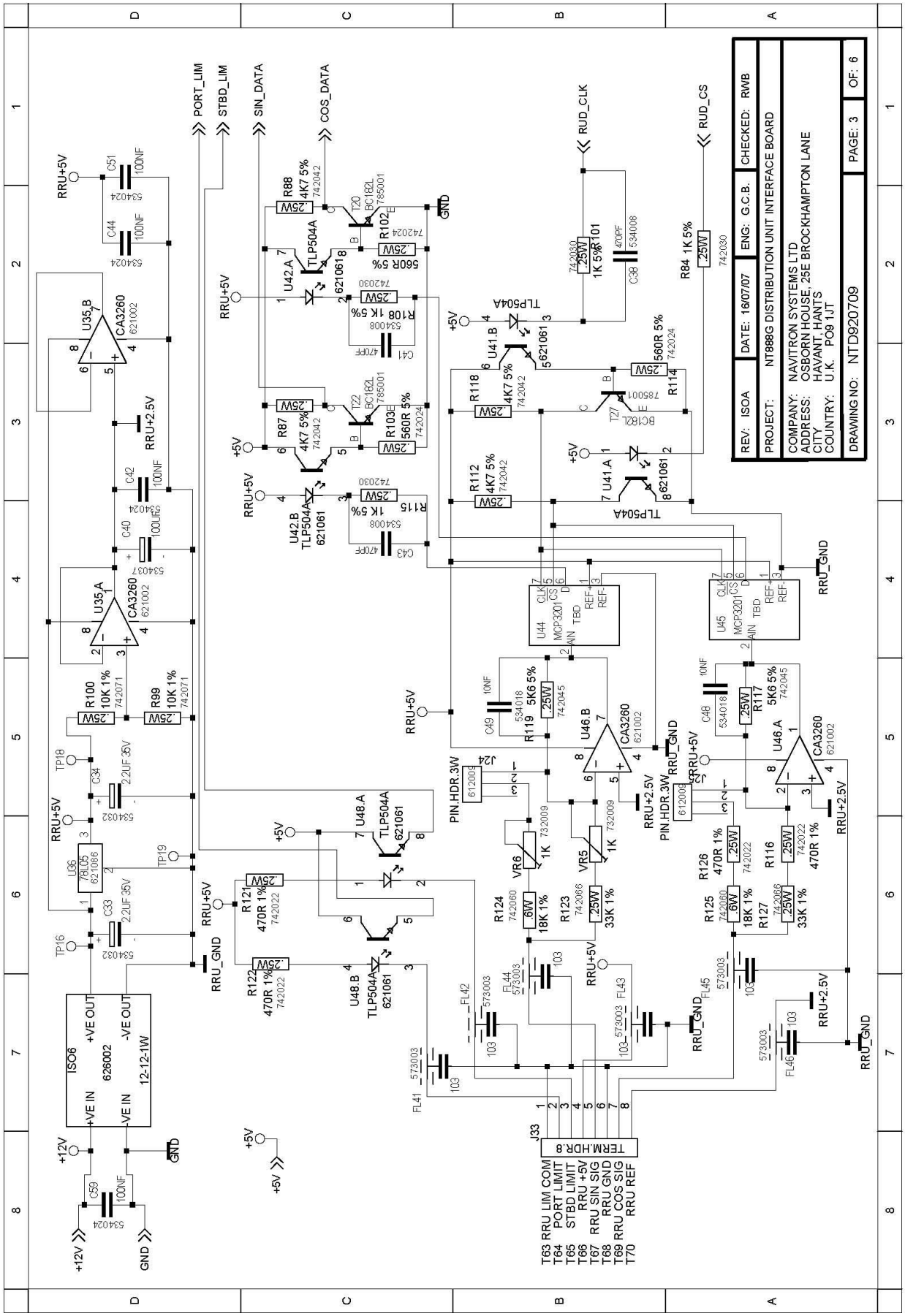
TM4.11: NT888G Main PCB Schematic NTD920710 Page 1.



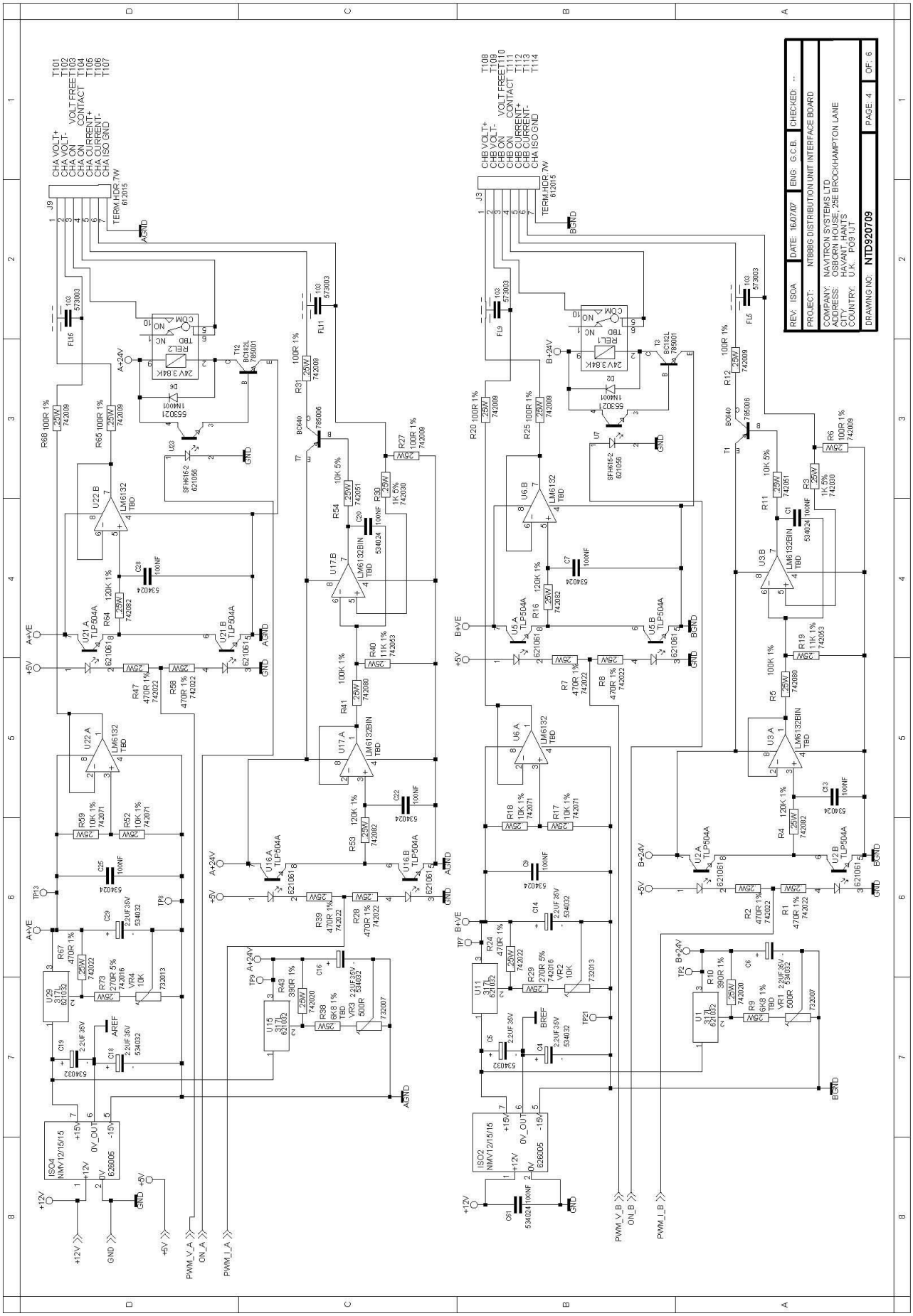
TM4.11: NT888G Main PCB Schematic NTD920710 Page 4.



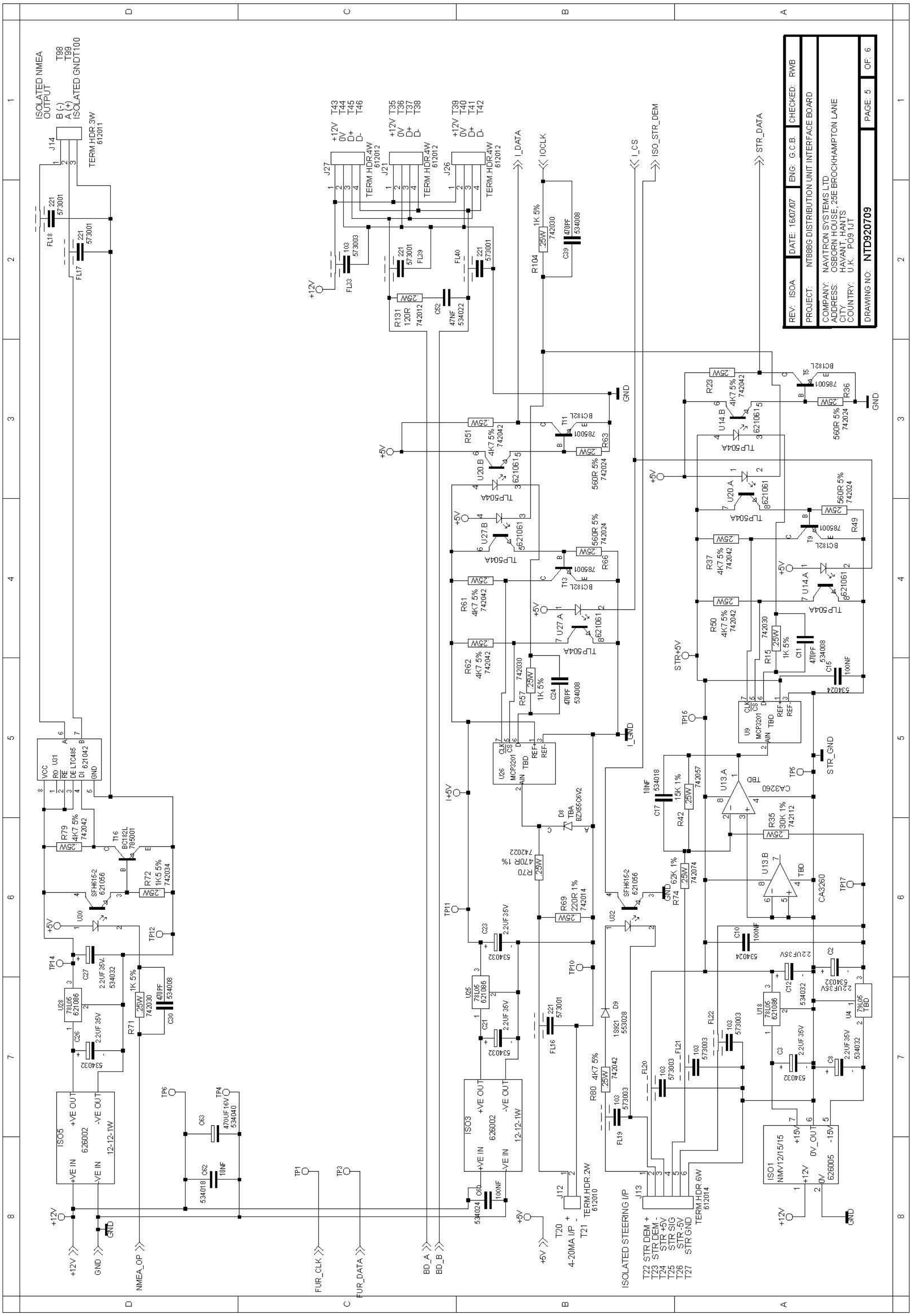
TM4.12: NT888G Connector PCB Schematic NTD920709 Page 2.



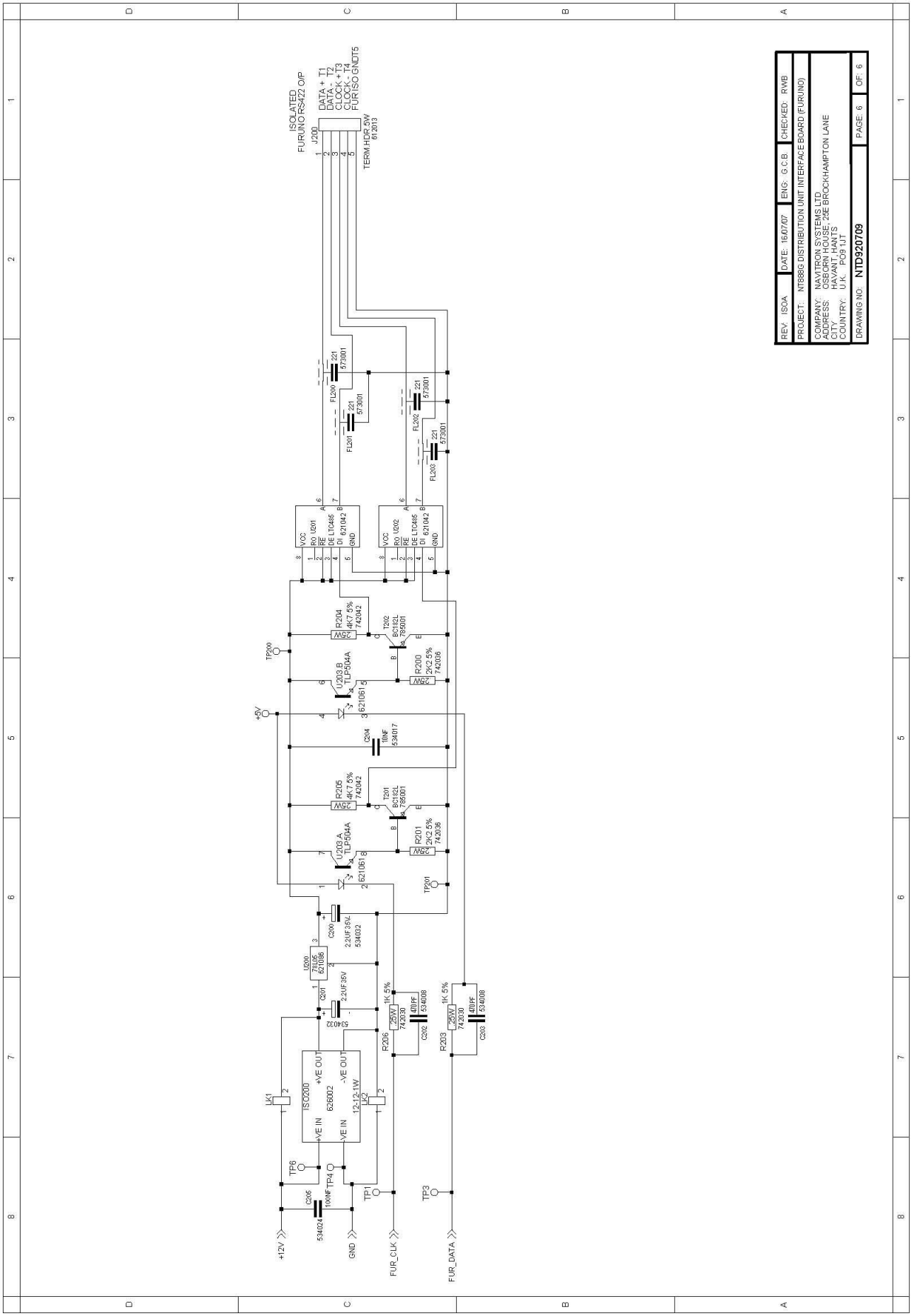
TM4.12: NT888G Connector PCB Schematic NTD920709 Page 3.



TM4.12: NT888G Connector PCB Schematic NTD920709 Page 4.



TM4.12: NT888G Connector PCB Schematic NTD920709 Page 5.



TM4.12: NT888G Connector PCB Schematic NTD920709 Page 6.

Section TM5: The NT888G Diagnostic Mode.

The Autopilot software includes a diagnostic facility, which enables fault conditions to be traced. This is a non operational aspect which should only be referred to in conjunction with advice from Navitron Systems Ltd should the need arise.

TM5.1: To Enter Diagnostic Mode:-

(i) The Autopilot can be operational in the **STANDBY, ON** or **TRACK** mode in readiness for diagnostic mode entry.

(ii) Simultaneously operate the **TRACK** and **AUTOTRIM** (OFF/SET) keys for a period of 5 seconds until **"DIAGS"** appears on the Control Unit display to confirm entry to the diagnostic mode.

(iii) There are 13 diagnostic screen sets which are displayed/stepped through in turn commensurate with **REMOTE** key operation. Each screen set shows real time information related to data communication, component signal integrity and voltage regulation within the Autopilot system.

Set 1:-

DEVIATION - Shows the correction value for each Compass Heading.
DET C.U.S. - Lists active Control Units (i.e. 0021 = Control Units active at addresses 1 and 2.
DET RSC - Lists active Remote steer Controls.

Set 2:-

SENT IN - The incremental sum of sentences received from the NT888G Distribution Box.
SENT OUT - The incremental sum of sentences sent to the Dist. Box.
ERRORS - The number of errors (sent in/out as above).

Set 3 to 5:-

These 3 sets relate to NMEA data inputs applied to Distribution Unit inputs 1, 2 and 3 and show sentence details etc. which can be inspected by scrolling through (1, 2, 3) using the Control Unit **REMOTE** key.

Set 6:-

Phase 1 - The Phase 1 output magnitude (volts) from the Compass.
Phase 2 - The Phase 2 output magnitude (volts) from the Compass.
Phase 3 - The Phase 3 output magnitude (volts) from the Compass.
MAGNITUDE - The sum of all phases (should not be zero).
OFF SET - The DC OFF Set of the Compass (should be less than 60).

Set 7:-

R.R.U. - Voltage levels returned from the Rudder Reference Unit (single ended and sin/cos).
R.S.C. - Voltage level applied from the Remote steer Control.
COUNTER - Signal voltage from Counter Rudder output stage.
+7V - Monitor of internal Distribution Unit +7V regulated line.
+3.5V - Monitor of internal Distribution Unit +3.5V regulated line.

TM5.1: To Enter Diagnostic Mode (Continued):-

+2.5V - Monitor of internal Distribution Unit +2.5V regulated line.

Set 8:-

FOLOW UP - Status of Remote Steer Control (FU) demand line.
NO FOLOW UP - Status of Remote Steer Control (NFU) demand line.
DODGE - Status of Remote Steer Control (Dodge) demand line.
REM STBY - Control Unit status (0001 = Remote Standby, 0000 = normal)
PORT LIM - Confirms status of Port limit switch (0001 = closed, 0000 = open.)
STBD LIM - Confirms status of Stbd limit switch (0001 = closed, 0000 = open.)

Set 9:-

The NT888G Distribution Box contains 6 microcontroller devices, each one of which has a dedicated software standard as shown in Sets 9 & 10 and also at initial Power Up (first screen display):-

PRC 1 VER - Software Version of processor No. 1.
PRC 2 VER - Software Version of processor No. 2.
PRC 3 VER - Software Version of processor No. 3.
PRC 4 VER - Software Version of processor No. 4.
D.B. TYPE - Distribution Unit Type (0888).

Set 10:-

PR5 VER - Software Version of processor No. 5.
PR6 VER - Software Version of processor No. 6.

Set 11:-

RRU A COS. - Voltage level returned from Rudder Reference Input.
STR A - Voltage level returned from Isolated Steering Input.
DRAFT - Current level returned from 4-20mA Draft Input.

Set 12 & 13:-

These two sets relate to NMEA data inputs applied to Distribution Unit Speed inputs and show sentence details etc.

TM5.2: To Exit the Diagnostic Mode.

Simultaneously operate the **TRACK** and **AUTOTRIM** (OFF/SET) keys for a period of 5 seconds until the expected operating display appears on the NT888G Control Unit to confirm exit from the diagnostic mode.

Section TM6: NT888G DB Main Connector Layouts/Schematics.

&

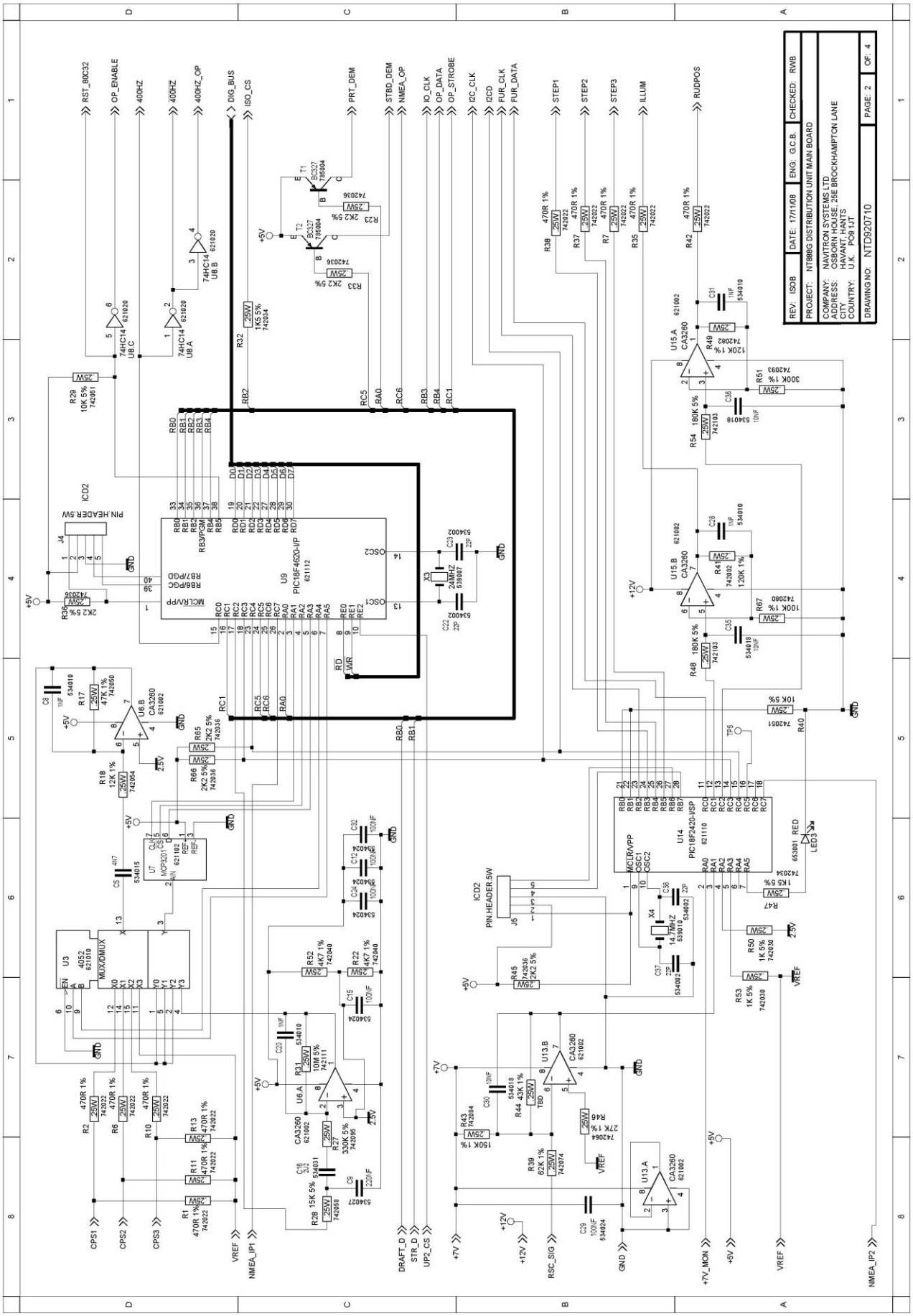
Section TM7: NT888G CU PCB Layout/Schematics

TM6: The **NT888G Distribution Unit PCB** details are contained within the Installation & Technical Manual as follows:-

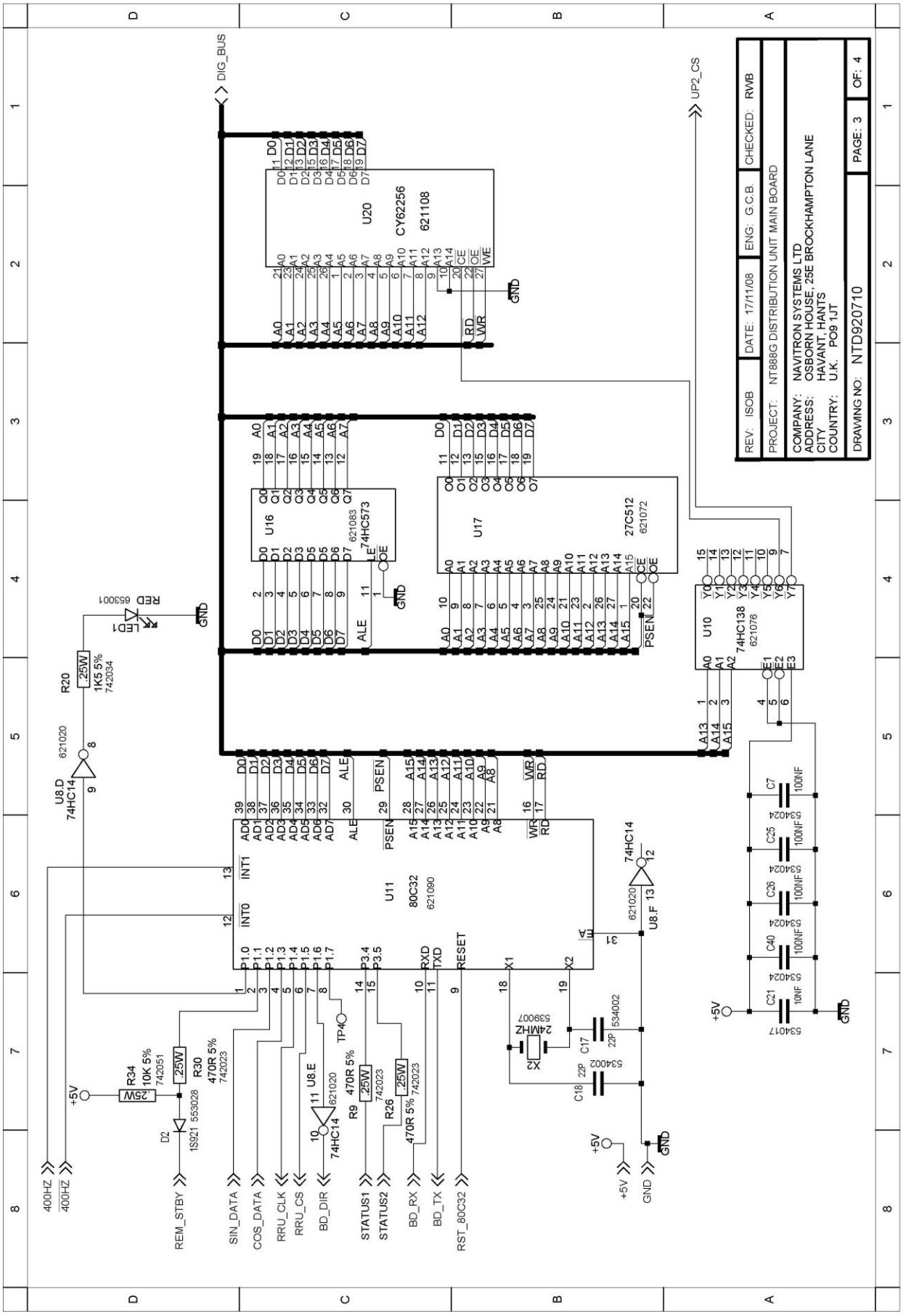
(i) Mechanical Fixings / Locations – Section TM1.2.
(ii) Main & Connector PCB component Layouts – Section TM4.
(Drawings NTD920738 & NTD920737)
(iii) Main PCB schematics (NTD920710 Sheets 1 & 4) - Section TM4.
(iv) Main PCB schematics (NTD920710 Sheets 2 & 3) - Section TM6.
(v) Connector PCB schematics (NTD920709 Sheets 2 – 6) - Section TM4.
(vi) Connector PCB schematics (NTD920709 Sheet 1) - Section TM6.

TM7: The **NT888G Control Unit PCB** details are contained within the Installation & Technical Manual as follows:-

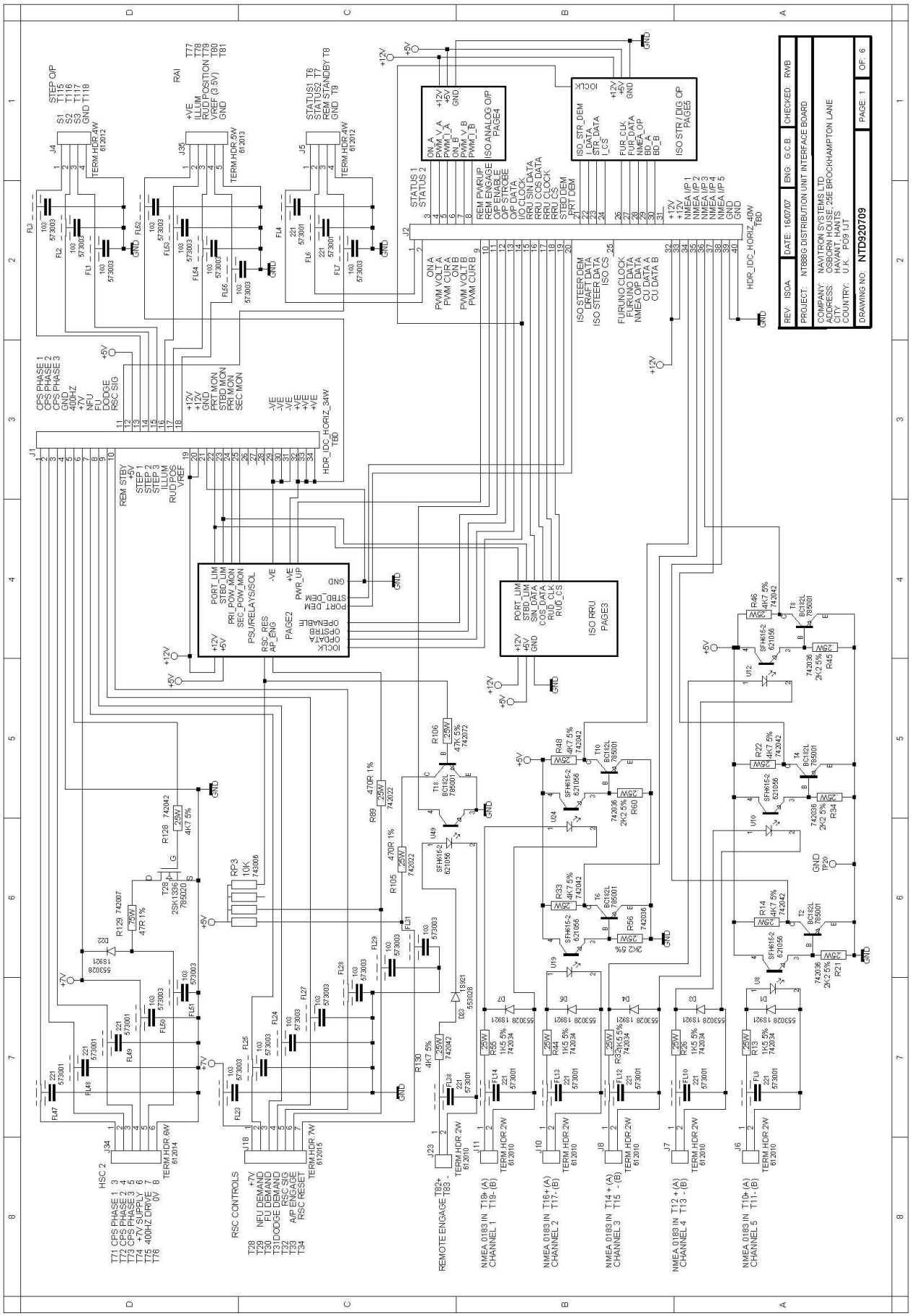
(i) Mechanical Fixings / Locations – Section TM1.5.
(ii) Control Unit PCB component Layouts – Section TM7.
(Drawing NTD920720)
(iii) Control Unit schematics (NTD920706 Sheets 1 & 2) - Section TM7.



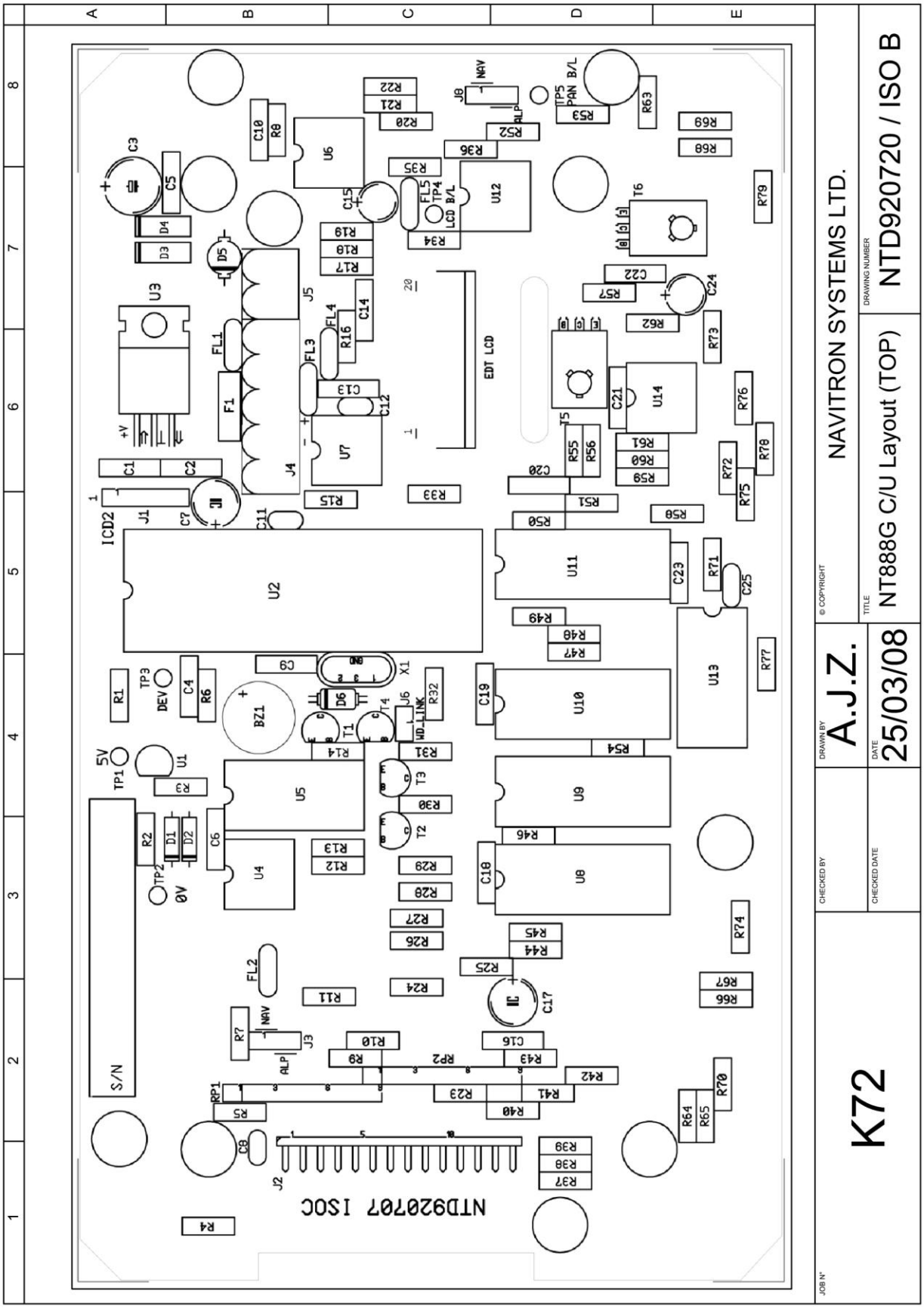
TM6 (iv): NT888G Main PCB Schematic NTD920710 Page 2.



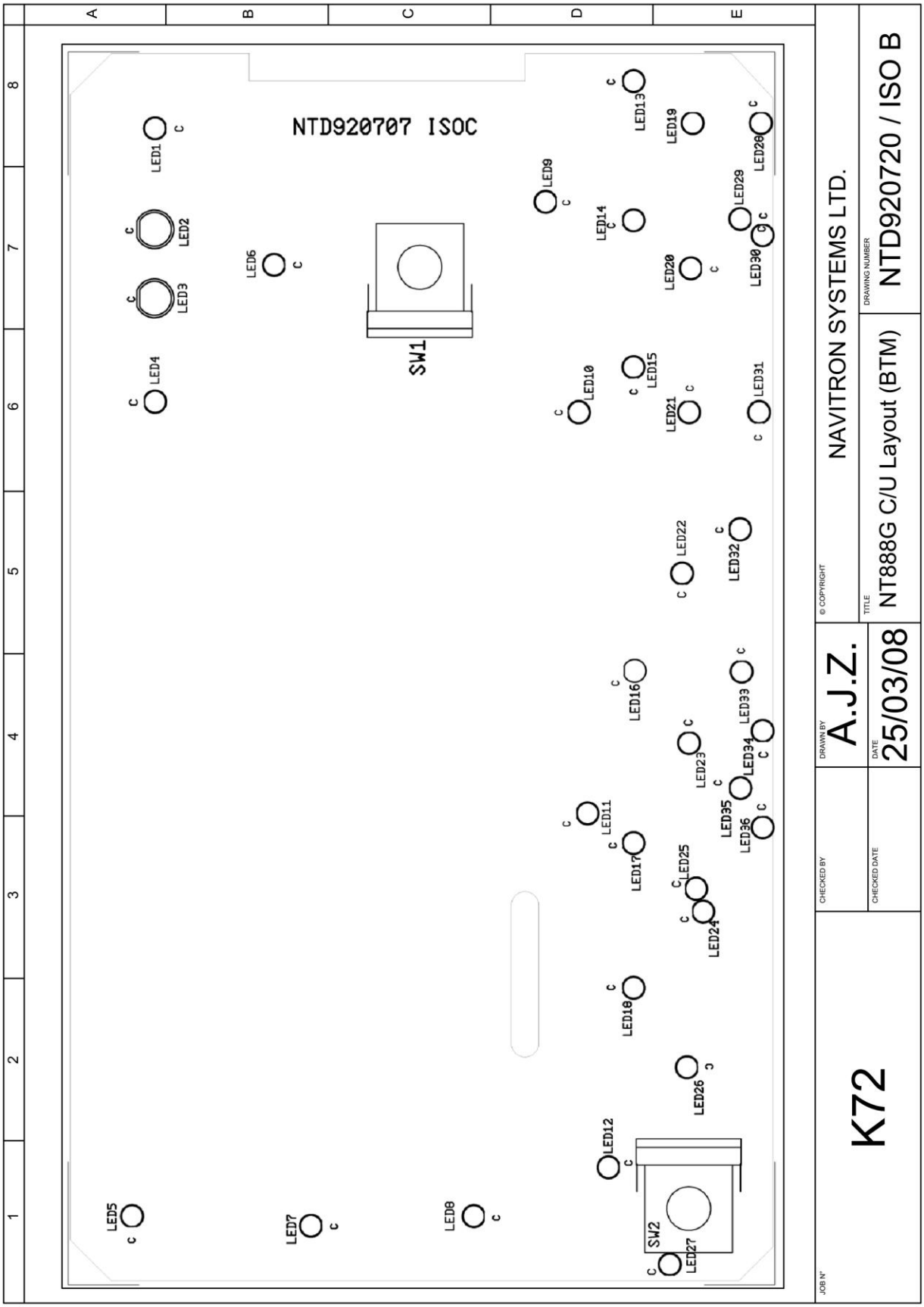
TM6 (iv): NT888G Main PCB Schematic NTD920710 Page 3.



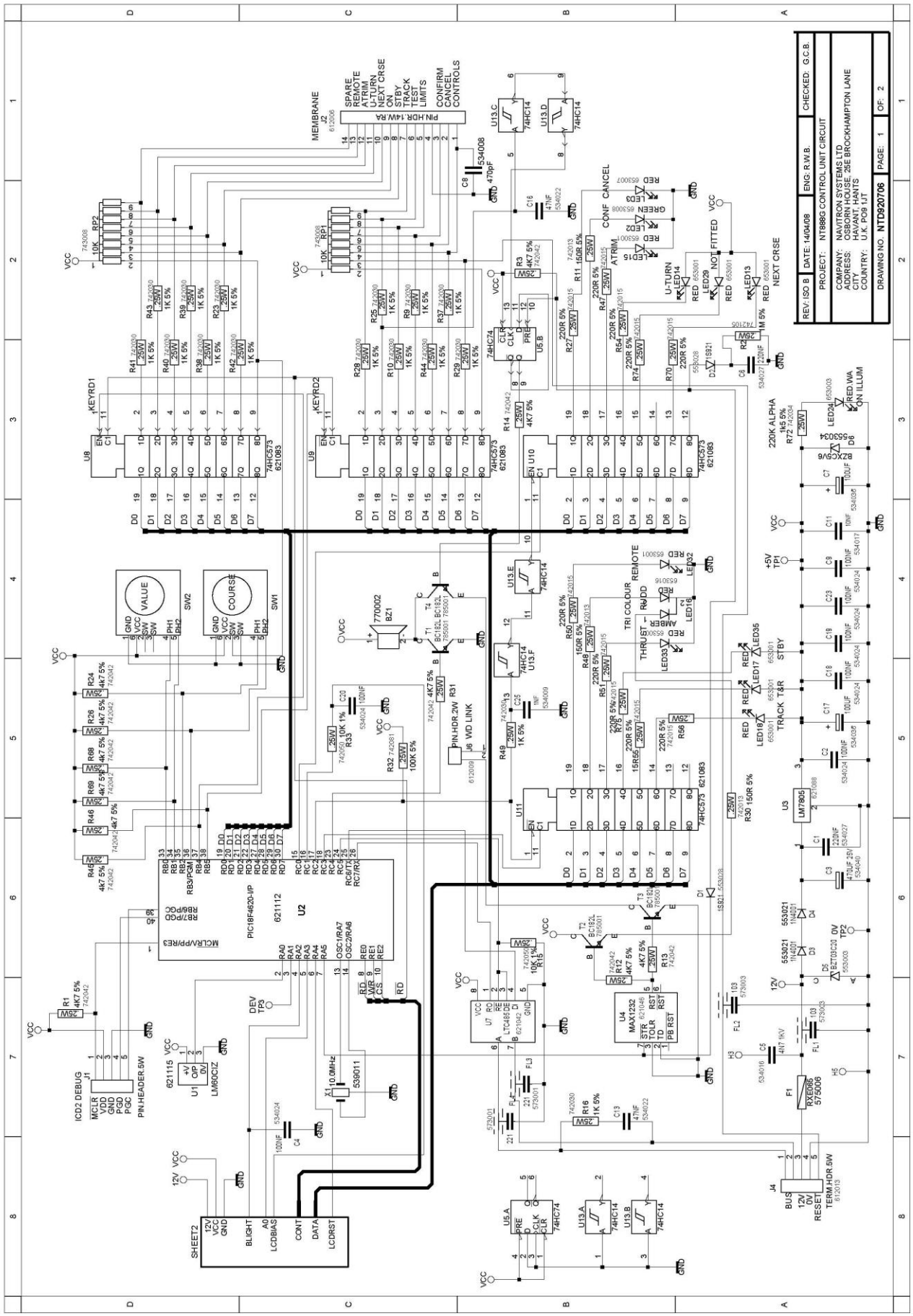
TM6 (vi): NT888G Main PCB Schematic NTD920709 Page 1.



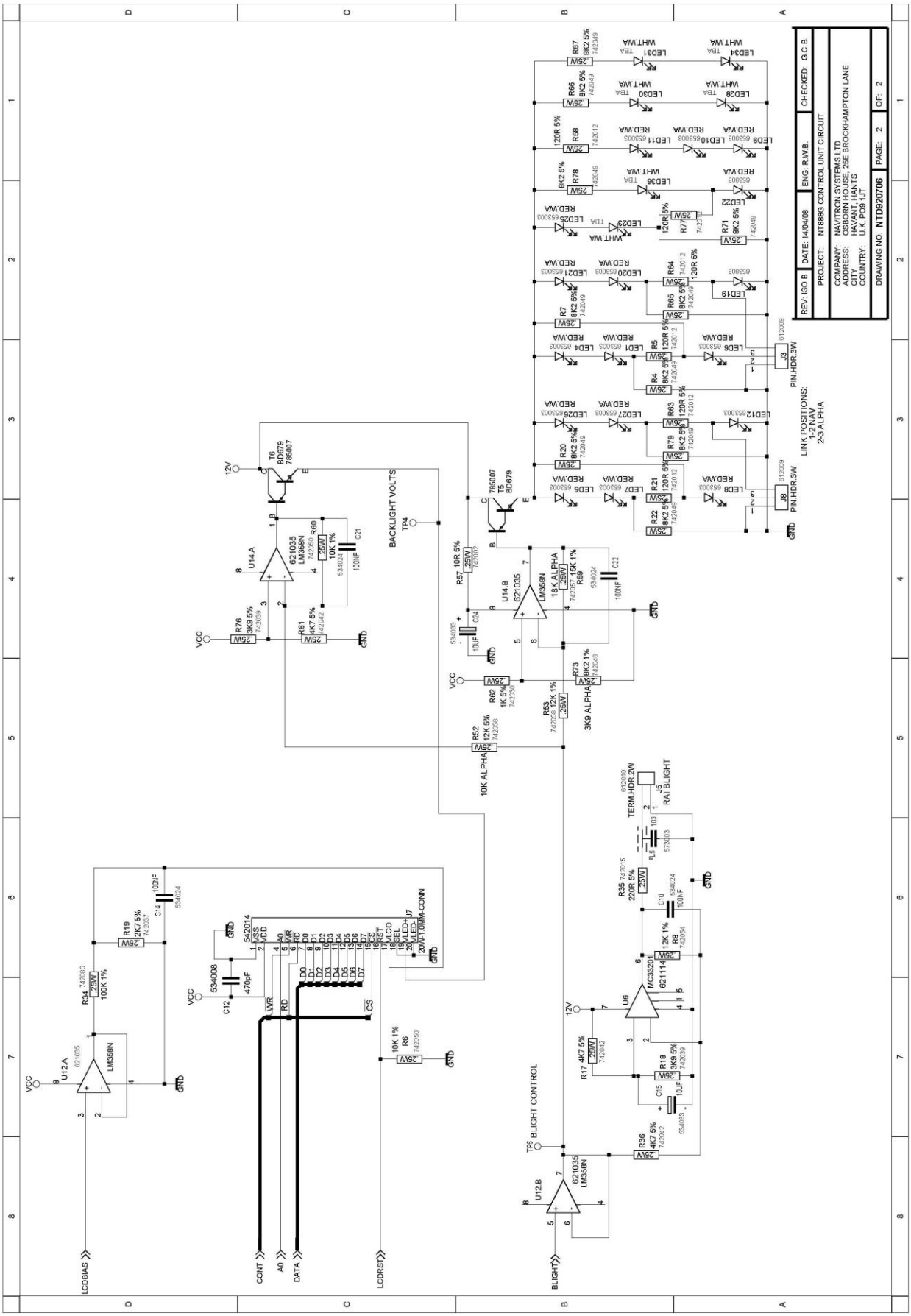
TM7 (ii): NT888G Control Unit PCB Layout Top.



TM7 (ii): NT888G Control Unit PCB Layout Bottom.



TM7 (iii): NT888G Control Unit PCB Schematic NTD920706 Page 1.



TM7 (iii): NT888G Control Unit PCB Schematic NTD920706 Page 2.