GENERAL DESCRIPTION of the WAGNER LORAN TRACKER LT180S

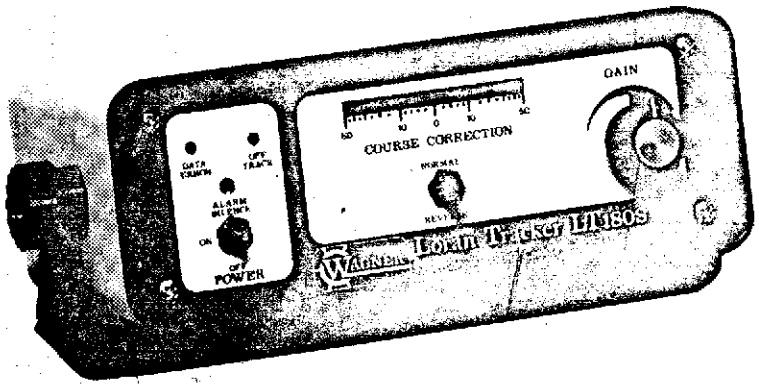
The Wagner Loran Tracker LT180S Loran C/Autopilot coupler is an interface for converting digital position data from Loran C receivers (data must be in the NMEA 0180 standard format) to steering signals for the Wagner Mark 4, S50, and S.E. Autopilots.

The unit incorporates a micro-computer and adaptive software to provide varying control response over a wide range of operating conditions on virtually any type of vessel. This unit will acquire and maintain a programmed Loran C track with exceptional accuracy (often within 20 feet), compensating for autopilot course setting error, winds, and tides while monitoring the continuing operation of the Loran C transmitters, receiver, autopilot, and steering gear.

When used with a Loran C receiver capable of trip programming (or multiple waypoint sequencing), the LT180S can execute precise automatic course changes up to 50 degrees on each side of the course set on the autopilot, for a total of 100 degrees, making hands-off navigation from dock to dock realistically conceivable.

Installation is extremely simple. The unit has only two cables to connect: a data cable from the Loran C receiver and a combined power and signal cable to the autopilot.

Operation is easy and fail-safe, with a minimum of controls and a clear indication of operation and status from the bar-graph steering display and the warning annunciators.



SECTION I: SUMMARY OF OPERATION

To initiate automatic steering of a Loran C track with the Wagner Loran Tracker LT180S, use the following procedure:

1. Set the desired destination co-ordinates on the Loran C receiver and initiate the "steer-computed-line" function. This will start the transmission of steering data to the LT180S.
2. Turn on the Autopilot and set it to the heading indicated by the Loran C receiver (if a "heading to destination" feature is provided) or set it to the calculated course to the desired destination. This calculated course may be approximate, but should be within 30 degrees or less.
3. Turn the LT180S switch "ON" and turn the GAIN control to the 9 o'clock position. The COURSE CORRECTION switch must be in the "NORMAL" position.

Now observe the operation of the system. If the Loran C signal from the receiver to the LT180S is valid, there will be no alarm indications (after the programmed two second power-up test of the lights and horn). The Loran C track will be automatically steered to the selected destination.

If the "DATA ERROR" light and horn activate 12 seconds after the unit is turned on, the LT180S is not receiving data from the Loran receiver.

If, during normal operation, the "DATA ERROR" light and horn activate, it is an indication of possible transmission faults, or lost or weak Loran C signals. This will be confirmed by visual alarm indications on the receiver displays. Parity (data-test) errors or loss of data from the receiver will also be indicated by an alarm. During the alarm condition, the last valid data block is stored and used to maintain course.

The "OFF-TRACK" light and horn activate if the vessel falls off the selected Loran C track by more than 0.5 microseconds (300 feet or 0.05 nautical miles if operating with a Loran C receiver capable of LAT/LONG navigation). The alarm horn can be cancelled at any time by momentary "up" action on the POWER switch, but the alarm lights will remain illuminated until the condition causing the alarm returns to normal.

The COURSE CORRECTION LED bar-graph display indicates the degree and sense (direction) of the course correction that the LT180S is applying to the magnetic course set on the Autopilot in order to maintain the desired Loran C track as commanded by the Loran C receiver. If the sense of the steering signal is reversed by operating a base-line extension area of a Loran C chain, the COURSE CORRECTION switch should be set to "REVERSE" to obtain a normal display.

If the correction indicated increases to full scale (approximately 50 degrees course correction), the initial magnetic course was not set close enough to the Loran C track selected and must be reset. Switch the autopilot to "COMPASS REPEATER" mode if a Mark 4, or to "SET" if a S.E. or S50, and turn the LT180S "OFF". This will reset the correction circuits. Orient the autopilot course dial to the present heading (the RED port light and the GREEN starboard lights will both be out or "nulled").

When operating in a fringe area of a Loran chain where the Lines of Position (LOP's) are very widely spaced, the GAIN control can be turned up (clockwise) in order to maintain tight course control if desired. However, this will not be necessary when the Loran C receiver is in the LAT/LONG mode.

SECTION II: FRONT PANEL CONTROLS AND ANNUNCIATORS

A. CONTROLS

1. **POWER SWITCH** - This main switch connects the power from the autopilot and data signals from the Loran C receiver to the LT180S when moved to the "ON" position, and cancels the alarm horn in the "ALARM SILENCE" position. Turning the unit "ON" always initiates a two second test of alarm lights and horn and a twelve second wait for valid data from the Loran C receiver (before activating the alarms).

2. COURSE CORRECTION SWITCH - This switch permits visual correction of the Loran course steered when operating in a signal reversal area of the Loran chain. A normal appearing (direction) bar-graph display can be obtained by setting the switch to the "REVERSE" position (if signal reversal is not provided in the Loran C receiver controls).

   The course correction switch also has a unique and possibly life-saving additional function. If it is necessary at any time to quickly and accurately retrace the course just travelled (as may be required in a man-overboard situation), the switch may be flipped to the "REVERSE" position and the autopilot course dial rotated 180 degrees. The LT180S will then guide the vessel back along the original course without having to take time to reprogram the Loran C receiver and without the risk of making a data entry error under the stress of an emergency situation.

3. GAIN CONTROL - This control, when turned clockwise beyond the "normal" 9 o'clock position, provides compensation for fringe area operation. The "normal" gain position was selected to provide optimum steering resolution for operation within or near the triangle formed by the baselines of the master and secondary stations where the LOP's (lines of position) are closely spaced. The "normal" position is also an optimum setting for LAT/LONG operation, providing constant cross-track output in all usable areas of a Loran chain. In the fully clockwise position, the gain is four times the gain in the "normal" position. An internal gain control, in tandem with the front panel control, allows selection of other gain settings in "normal" and maximum positions, and provides a broad range of adjustment to accommodate autopilots other than the S.E., S50, or Mark 4. See SECTION IV: INTERNAL ADJUSTMENTS, A.1.

4. An automatic dimming control is provided for the COURSE CORRECTION LED bar-graph display.

   A light sensor, mounted behind the clear circular window above the POWER switch, controls the display brightness in response to ambient light conditions. The range of this control is internally adjustable if other than the factory setting is desired. See SECTION V: INTERNAL ADJUSTMENTS, A.2.

B. ANNUNCIATORS

1. The "DATA ERROR" alarm indicator light is activated, along with the alarm horn, by the following conditions:

   a) A data warning signal generated by the Loran C receiver. The conditions for which the receiver will send this warning signal vary in detail from one receiver manufacturer to another, but will include transmitter blink, cycle selection ambiguity, and loss of signal.

   b) A receiver fault that causes failure to transmit valid code. Each binary data block sent to the LT180S is checked by the processor for the specific data bit that indentifies autopilot data. Binary data blocks are also checked for "parity" (an error detecting code derived from the sum of "ones" in the data block). The NMEA 0180 data format used in the LT180S specifies "odd" parity which means that the total number of ones in the block is always made an odd number by the Loran C receiver. If either the autopilot identifier bit or the parity bit is wrong, the binary data block is rejected. The LT180S does not trigger an alarm if every data block does not contain an autopilot identifier bit, because other devices (as well as the autopilot) may also be receiving data from this same serial data port, using data blocks with other identifiers or formats. However, the LT180S must receive at least one valid autopilot data block every twelve seconds or it will initiate the "DATA ERROR" alarm.

   c) Any failure in the data transmission as a result of a broken or intermittent circuit. Valid autopilot data must be received by the LT180S during any 12 second period. If the Loran C signal and receiver are known to be good, but alarms are activated, a thorough check of the interconnecting cable and connectors is required.

   The alarm horn can be cancelled at any time by momentary 'up' action on the POWER switch, but the "DATA ERROR" light will remain on until the condition is corrected. During this alarm condition, the last valid data from the Loran C receiver is stored and used to maintain course.

2. The "OFF TRACK" alarm indicator light is activated, along with the alarm horn, when the vessel falls off the programmed Loran C course more than a preset distance defined by increments of error. The LT180S is programmed to trigger "OFF TRACK" after passing through five increments of off-track error, but the increment size is determined by the Loran C grid spacing (or gradient) in the area of operation as well as the receiver programme and mode of operation. The Loran C gradient in usable signal areas varies from 50 feet to 200 feet per 0.1 (one tenth) microsecond time difference.

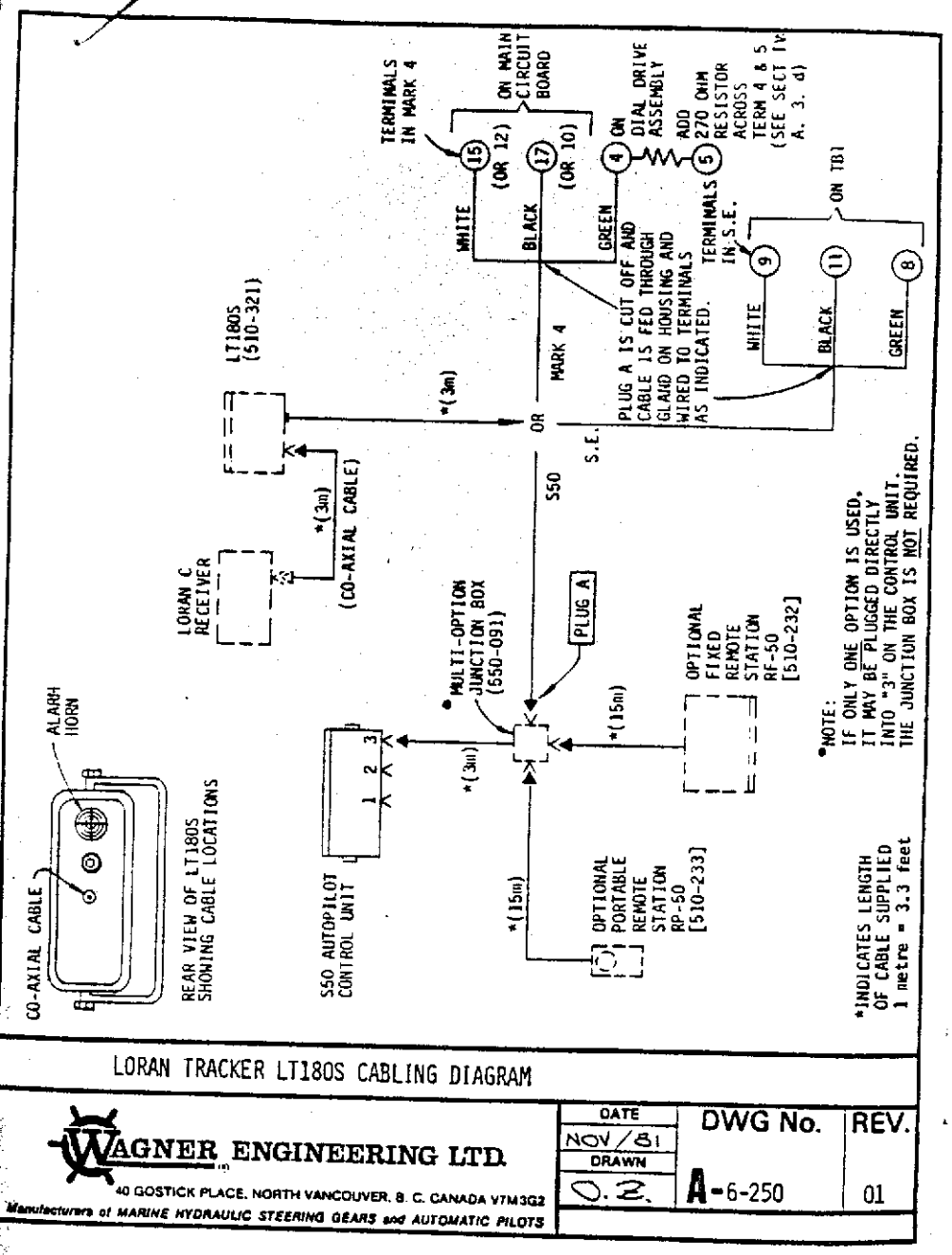
   The Loran C receiver data output varies from one manufacturer to another -- from 0.1 microsecond distance increments off the desired track to course change degree increments required to arrive at the desired destination, but all are functionally equivalent.

   In the LOP (line of position) or TD (time difference) mode, the off-track alarm will trigger at 300 feet of error in optimum areas and up to 1200 feet in fringe areas.

   If the Loran C receiver is operating in the LAT/LONG mode, the off-track output data will be in constant distance increments of 0.01 (one hundredth) of a nautical mile (approximately 60 feet) throughout the usable signal areas of the Loran C chain. The off-track alarm will therefore indicate when the vessel is approximately 400 feet off-track.

3. The COURSE CORRECTION LED bar-graph display shows the operator the approximate degrees of course correction the LT180S is applying to the autopilot course setting to maintain the desired Loran C track.

   This display is logarithmic and more sensitive near zero where one division equals two degrees.



LORAN TRACKER LT180S CABLING DIAGRAM

WAGNER ENGINEERING LTD.
40 GOSTICK PLACE. NORTH VANCOUVER. B. C. CANADA V7M3G2
Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
NOV/81	A-6-250	01
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O. N.		

SECTION III: INSTALLATION AND TESTING (Refer to DWG. No. A-6-250)

The LT180S is powered by the S50 or Mark 4 Autopilot with which it is installed.

A three metre length of interconnecting cable is supplied with a connector (Plug A on drawing) to plug directly into the Series 50 Autopilot Control Unit receptacle normally used for a remote control. If one or more remote controls are to be used with the S50 Autopilot, the Multi-Option Junction Box (P/N 550-091) must be used.

If the LT180S is used with the Mark 4 Autopilot, the connector (Plug A on drawing) must be cut off the cable. The cable is then fed through the gland fitting on the Mark 4 housing. The white and black wires in the cable are connected to the Mark 4 circuit board terminal strip (as indicated on the drawing) and the green wire is connected to terminal 4 on the dial drive terminal strip. The 270 ohm resistor included with the unit must be connected across terminals 4 and 5 of the dial drive terminal strip. The compass sensitivity, RT-1 on the Mark 4 Autopilot circuit board, must be adjusted as per SECTION III: A.9. in the Mark 4 manual and then the setting of the course correction output on the LT180S Front Panel Circuit Board must be adjusted as described in Section IV: A.3. of this manual.

A three metre length of co-axial cable is also supplied with a connector at one end and free wires at the other to attach to the connector (usually) supplied with the Loran C receiver. The cable shield is to be connected to the Loran C receiver signal "low" or ground pin and the shield or chassis pin if permitted by the Loran C manufacturer. The connection of these two points together should be verified in the manual supplied with the Loran C receiver and should be made, if not specifically advised against. The central conductor of the co-axial cable is connected to the receiver "high" or positive autopilot signal output pin.

The LT180S is ready for testing as soon as all cable connections have been completed as described.

A SELF TEST FEATURE is provided to confirm that the LT180S is working properly with the autopilot and that the course correction is calibrated. (The cable between the Loran C receiver and the LT180S must be disconnected to perform this test.) The LT180S POWER switch must be in the "OFF" position. To activate this test, turn the autopilot "ON" and place in the "COMPASS REPEATER" (if Mark 4 Autopilot) or "SET" (if S.E. or S50 Autopilot) mode. Move the LT180S POWER switch from "OFF" to the "ALARM SILENCE" position in one motion and hold it for at least three seconds. The LT180S will then simulate zero off-course data received.

A momentary 'up' action on the POWER switch will simulate off-course to port. Adjusting the gain control will vary the amount of course correction indicated.

To verify operation of the wind/tide correction circuits, switch the LT180S "OFF" and restart the SELF TEST PROCEDURE. Apply two momentary 'up' pulses on the POWER switch. The course correction display should indicate approximately ten degrees starboard, then slowly increase toward "50".

The LT180S is returned to the normal operating mode by turning the POWER switch to "OFF" and then "ON" again, or if valid data is applied to the input connector.

SECTION IV: INTERNAL ADJUSTMENTS

Three adjustment points are located inside the LT180S. All are factory pre-set, and with the exception of the display dimmer adjustment, they are not considered user controls and should never be adjusted without a thorough understanding of the sophisticated circuitry and the precision measurement and calibration instruments necessary to service this circuitry.

A. FRONT PANEL CIRCUIT BOARD (Refer to DWG No. C-6-233-06)

Three adjustment points are included on this board.

1. The gain of the level shift amplifier, U9-section B, is set by RV-4. This gain must be exactly 2 to shift the digital-to-analog converter (U9 on the micro-processor ciruict board) output from 4 VDC full scale, up to 8 VDC full scale. To do this, the output of the D-A converter must first be brought to a binary offset zero corresponding to zero off-track error by activating the self-test mode as described in SECTION III: INSTALLATION AND TESTING.

   Using a digital voltmeter set on the 200 millivolt range, measuring between + 4 VDC signal reference (U2, pin 7) and U9-section B output (pin 7), adjust RV-4 to zero the output voltage (within ± 10 millivolts).

2. RV-1 sets the lower limit of the automatic dimming circuit that controls the brightness of the COURSE CORRECTION LED bar-graph display. It is factory adjusted to be easily read in near-total darkness and yet not be too bright for eyes accustomed to a very low light level.

3. The calibration of the course correction output is factory pre-set by RV-2 to produce a course correction of 40 degrees (port or starboard display on the front panel os the LT180S) when connected to the Wagner S50 Autopilot. To check the calibration after repair (or to make this calibration for use with a Wagner MK4 Autopilot -- see description at the end of this section), a technician must first obtain a 40 degree COURSE CORRECTION display on the LT180S by using the self-test mode as described in SECTION III: INSTALLATION AND TESTING. A Loran C receiver may be used to generate off-track data signals for calibration, but the results will be less precise due to the signal jitter and instability usually encountered.

   Calibration with a Wagner S50 Autopilot

   With the LT180S COURSE CORRECTION display indicating 40 degrees correction to port, adjust RV-2 until the autopilot course dial null (when red and green, port and starboard, lights go out) is off-set 40 degrees from the null point when the LT180S display was centred. This is easily and accurately set and confirmed by gradually increasing RV-2, while switching the "NORMAL/REVERSE" switch between port and star-board correction and checking the null point until the port and starboard nulls are 80 degrees apart.

Calibration with a Wagner MK 4 Autopilot

The set-up procedure is the same for the receiver and the LT180S as with the Wagner S50 Autopilot, but the details concerning the autopilot nulling procedure differ. First, refer to SECTION III: INSTALLATION AND TESTING, and DWG No. A-6-250 for the cable connections.

The 270 ohm resistor, included with the LT180S, must be connected across terminals 4 and 5 on the MK 4 dial drive terminal strip. Adjust the compass sensitivity, RT-1 on the MK 4 circuit board, as per SECTION III: A. 7. in the MK 4 manual after adding this resistor.

Then, with the LT180S in the self-test mode, and the Wagner MK 4 Autopilot operational, switch the MK 4 to "COMPASS REPEATER" mode. The course dial will automatically align to the null.

With 40 degrees of COURSE CORRECTION displayed on the LT180S, note the MK 4 course dial indication and switch the LT180S to "REVERSE". Note the number of degrees to reach the new null on the MK 4 course dial. Adjust RV-2 on the LT180S FRONT PANEL CIRCUIT BOARD to obtain 80 degrees between the "NORMAL" and "REVERSE" nulls.

B. CONVERTING TO 'SI-TEX' DATA FORMAT

The Loran Tracker LT180S is shipped from the factory pre-set to accept NMEA 0180 standardized data format. Si-Tex receivers 717, 757, 767 and 787 have a non-standard data format output similar to NMEA 0180 but use a 4800 Baud rate (instead of a 1200 Baud rate), have inverted polarity and do not have a parity bit.

The Universal Processor Circuit Board incorporates a crystal controlled selectable baud rate generator. The baud rate is changed from 1200 to 4800 by moving jumper, J2, from pin "X" to pin "Y". There is no bit-rate setting potentiometer - the crystal maintains the correct bit-rate.

Jumper, J1, on the Universal Processor Circuit Board must be moved from the "X" pin to "Y" pin to permit the use of the inverted Si-Tex data.

A jumper resistor across pins "J" and "K" on the front panel circuit board must be moved to pins "H" and "J" to enable the processor to delete the parity check when using Si-Tex data. Note that the drawing on page 16 is a front-side view. The pins and jumper are on the back of this board. Looking from the backside, pin K is on the left, pin J is in the center, and pin H is to the right.

If a Si-Tex Loran C Receiver is to be used and the three described jumpers are moved as instructed, follow the SELF TEST procedure next as described in Section III: INSTALLATION AND TESTING. If the self-test procedure is completed successfully, plug in the data cable from the Si-Tex receiver (programmed and displaying cross-track error). The LT180S should produce a 'beep' signal and display cross-track correction. If it does not, or sounds a data error alarm, check the changeover procedure to see that all jumpers are in the correct positions for operating properly with Si-Tex data. Also check the data cable and connectors. See Section V.B.: TROUBLE SHOOTING.

SECTION V: SERVICE

A. ROUTINE MAINTENANCE

The Loran Tracker LT180S is all solid state construction and no routine maintenance is required other than periodic performance checks.

B. TROUBLE SHOOTING

The LT180S circuitry is based on the RCA Cosmac micro-computer and has self-test capability built into the programme memory. All functional outputs are tested for two seconds each time the unit is turned on. The "DATA ERROR" and "OFF-TRACK" lights as well as the alarm horn are also tested for two seconds each time the unit is turned on.

The COURSE CORRECTION LED bar-graph display is normally centred when the LT180S is turned on and remains centred if no valid data are present at the input. The unit will wait 12 seconds for valid data and if not received, activate the horn and the "DATA ERROR" light.

If the self-test at turn-on does not function and the 5 volt regulator, U3, on the FRONT PANEL CIRCUIT BOARD is not defective, the problem is caused by the plug-in micro-processor board and it should be replaced.

All other faults will originate with the FRONT PANEL CIRCUIT BOARD. The following table indicates the most probable cause of a fault and will assist diagnostic testing. (The LT180S is assumed to be connected to the Autopilot and Loran C receiver, and both are operating properly.)

PROBLEM	POSSIBLE CAUSE
The "DATA ERROR" light comes on 12 seconds after turn-on, but valid data are available from the Loran C receiver.	Shorted or open data cable or connectors. Data format jumpers incorrect. Faulty opto-coupler, U1.
No "DATA ERROR" or "OFF-TRACK" lights but output and bar-graph go full scale at turn-on.	Faulty op-amp chips, U9 or U2. Faulty analog switch chip, U8.
LT180S works but always arrives at destination off track to the same side.	Level-shift amplifier gain incorrect. Adjust RV-4. See SECTION V: INTERNAL ADJUSTMENTS, A. 1.
LT180S works but oversteers back and forth across the correct track.	Front panel GAIN control set too high. Decrease until stable course is achieved. Adjust internal gain control, RV-2, if normal "9 o'clock" setting of the front panel GAIN control is unstable. See SECTION V: INTERNAL ADJUSTMENTS, A. 2.

SECTION VI: TECHNICAL DESCRIPTION

The Loran Tracker LT180S employs very sophisticated electronic circuitry. We recommend that all service be performed by factory authorized technicians. CMOS micro-processor integrated circuits are used and can be damaged by handling if strict precautions are not taken. Static-safe work areas, tools and handling materials must be used whenever servicing is attempted. Replacement of the entire unit, an assembly or circuit board will result in faster and more economical field servicing.

A. FRONT PANEL CIRCUIT BOARD: (Refer to DWG No. C-6-233-03)

Regulator, U3, supplies +5 VDC for the micro-processor and the LED display from the +8 VDC autopilot power supply. The +8 volts powers all other analog circuits. Opto-coupler, U1, provides total electrical isolation of the serial data from the Loran C receiver.

U2-section A, and light sensor, LDR-1 and RV-1 comprise the automatic display dimming control.

U2-section B, functions as a power supply splitter, providing a +4 VDC signal reference.

U2-sections C and D, invert and buffer the steering signal output to the display and the autopilot.

U9-section B, shifts the ground referenced output of the DIGITAL-to-ANALOG converter on the processor board to +4 VDC reference.

U9-section C, is a low pass amplifier with a gain of 3 for steady state signals and phase-leading response before roll-off, to compensate the data-update delays of some receivers and dampen cross-track course oscillations.

U9-section D, is an integrator providing off-track error trim to correct for wind and tide or inaccuracies in autopilot course setting.

Analog switch, U8, resets the integrator on power-up and holds the trim setting during alarm conditions.

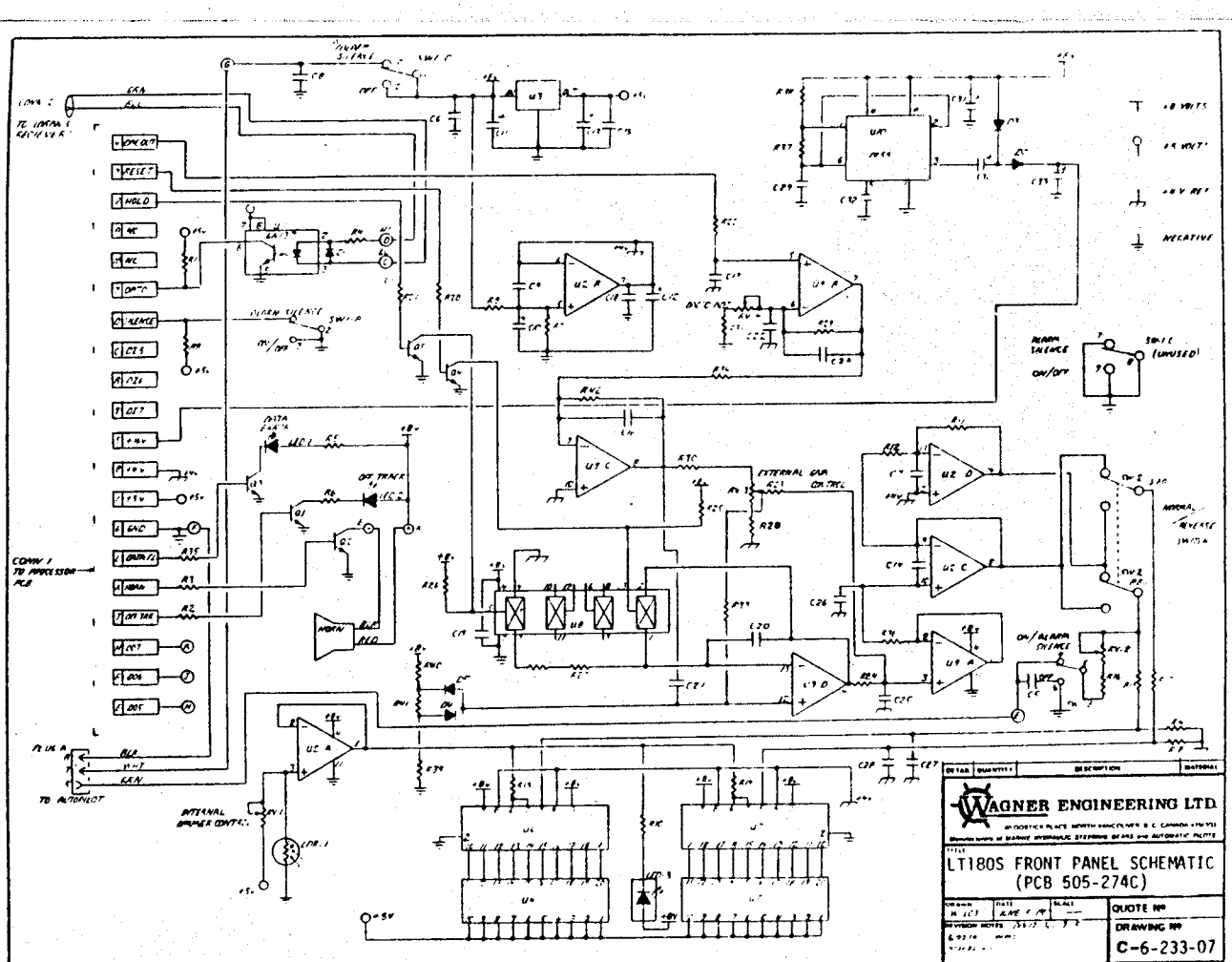
U9-section A, is a summing buffer that adds the steering amplifier and integrator outputs to produce the composite course correction signal for the output amplifiers, U2-sections C and D. Integrated circuits, U6 and U7, convert the port and starboard steering signals to ten-wire outputs to drive the bar-graph displays U4 and U5.

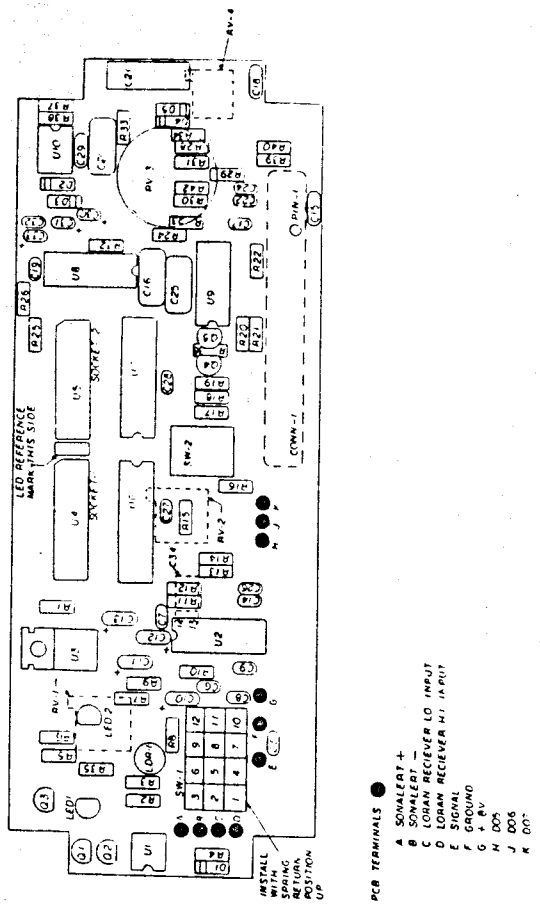
Transistors, Q1 through Q5, invert and buffer the processor outputs to drive the annunciator lights and horn and analog switches.

Astable multivibrator, U10, and associated components function as a voltage up-converter to supply 15 VDC to the DIGITAL-to-ANALOG converter, U9, on the processor board.

COMPONENTS LIST FOR LT180S FRONT PANEL CIRCUIT BOARD (PCB 505-274C)

COMPONENT	VALUE	PART No.
A-K (No letter "I")	AMP 60874-1	431-013
C5-9, 14, 15, 18, 19, 22, 26-28, 32, 34	.1mfd	400-024
C10	3.3mfd/Tant	401-029
C11-13	22mfd/16V	401-027
C16, 25	.22mfd	400-025
C17, 24	.01mfd/disc	400-010
C20	1mfd	400-040
C21	1.5mfd	400-048
C29	.01mfd	400-036
C30, 31, 33	10mfd/Tant	401-035
CONN 1	EDAC 307020520202	440-047
CONN 2	AMP 31-010	441-034
D1-3	1N4005	300-003
D4, 5	1N914	300-001
HORN	MALLORY NSP 428	480-016
LDR-1	VT871	136-002
LED 1, 2	PCE 200BR	303-002
LED 3	MV 57124	303-005
PCB	WAGNER	500-274A
Q1-5	2N4400	310-002
R1	330	100-088
R16, 30	1K	115-039
R2, 3, 28, 35, 37, 38	4.7K	115-042
R4	470	115-038
R5, 6	180	115-036
R7, 9	1K/1%	114-003
R8, 11, 12, 20, 21, 25, 26	10K	115-045
R10	390	115-037
R13, 19	3.3K	100-047
R14, 15, 17, 18	18K	100-030
R22	1M	100-044
R23, 24, 27, 32	22M	115-059
R29	11K/1%	114-020
R31	10.5K/1%	114-029
R33, 42	10M	115-058
R34	4.7M	100-041
R36	22K	115-046
R39, 40	47K	115-019
RV-1	10K Trimpot	130-042
RV-2	50K Trimpot	130-046
RV-3	100K Pot	130-028
RV-4	1K (Beckman - 69W)	130-040
SKT-1, 2	C91-20-00	360-024
SW-1	C & K 7413SYCQ	210-057
SW-2	JBTMPC 223	210-058
U1	6N137	320-008
U2	LM 324	350-005
U3	7805	315-014
U4, 5	MV57164	303-001
U6, 7	LM3915	350-018
U8	4066	360-012
U9	ICL7641ECPD	350-019
U10	555 Timer	350-002





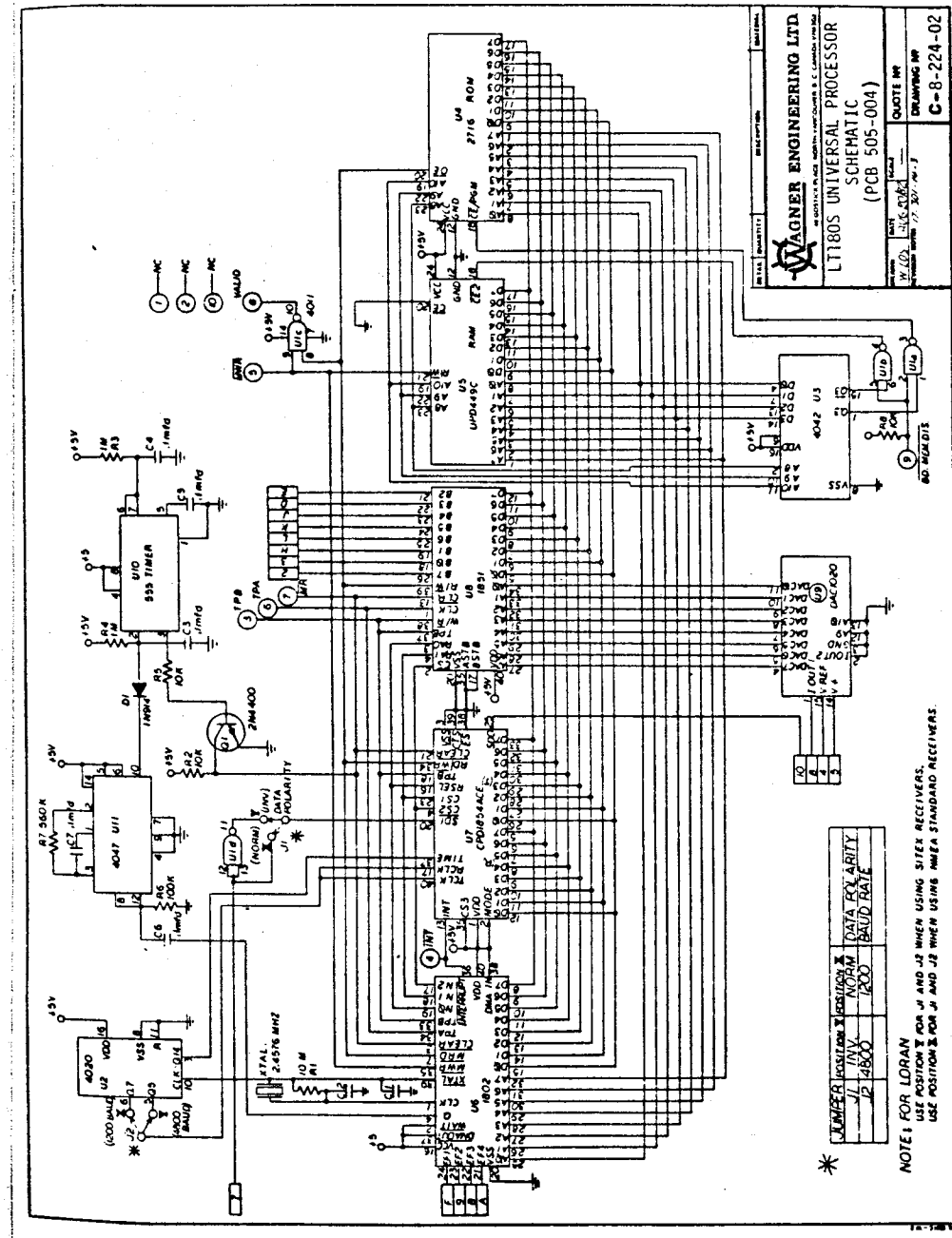
FRONT PANEL COMPONENT LAYOUT
(PCB 505-274C)

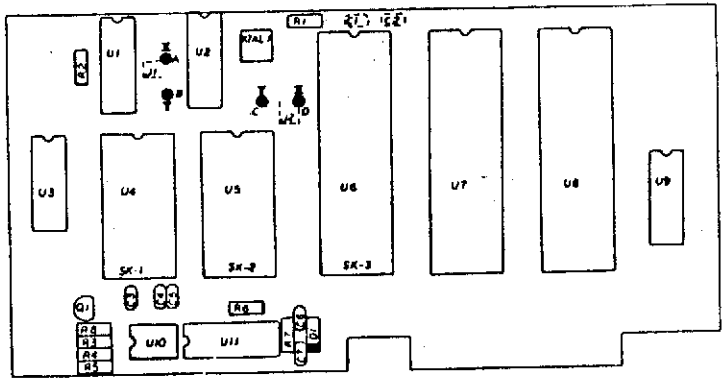
B. UNIVERSAL PROCESSOR CIRCUIT BOARD: (Refer to DWG No. C-8-224-02)

The RCA 1802 Central Processor Unit and peripheral circuits are used to perform the data receive, manipulation and output as well as all status signalling and timing functions of the LT180S. As micro-processor theory and servicing is comparatively complicated, it is considered beyond the scope of this manual and the facilities of most marine electronics service depots. It is therefore recommended that this board be tested by substitution and all repairs be performed at the factory.

COMPONENT LIST FOR LT180S UNIVERSAL PROCESSOR CIRCUIT BOARD (PCB 505-004)

COMPONENT	VALUE	PART NO.
C1,2	Select on factory test	
C3-7	.1mfd	400-027
D1	1N4148	300-001
J1,2	#24 Wire	750-122
PCB	WAGNER	500-023
Pin A-D	AMP 60874-1	431-013
Q1	2N4400	310-002
R1	10M/¼w	115-058
R2,5,8	10K/¼w	115-045
R3,4	1M/¼w	100-044
R6	100K/¼w	115-051
R7	560K/¼w	100-069
SKT 1,2	224-AG49D	360-031
SKT 3	240-AG49D	360-041
U1	4011 CMOS	360-015
U2	4020 CMOS	360-049
U3	4042 CMOS	360-025
U4	WAGNER EPROM 5	810-016
U5	UPD 449C CMOS RAM	360-048
U6	1802 CMOS PROCESSOR	360-026
U7	CDP 1854 ACE CMOS UART	360-047
U8	1851 CMOS PIO	360-046
U9	DAC 1020 LCN	360-030
U10	555 TIMER	350-002
U11	4047 CMOS	360-034
XTAL	2.4576 MHz	370-004





UNIVERSAL PROCESSOR COMPONENT LAYOUT
(PCB 505-004)