TECHNICAL MANUAL
FOR
COMPACT HF SSB AT2110
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1 INTRODUCTION

The SAILOR Compact HF SSB AT2110 is an automatic tuning aerial coupler for transmitter T2130 in SAILOR Compact HF SSB Programme 2000.

SAILOR Compact HF SSB Programme 2000 is a powerful, advanced, high technology short wave communication system, which is extremely easy to operate.

SAILOR HF SSB AT2110 has been developed on the basis of S. P. Radio’s many years of experience with construction of aerial couplers for use outdoors in maritime environments.

It has the same high reliability as all SAILOR equipment is known for.

SAILOR HF SSB PROGRAMME 2000 CONSISTS OF THE FOLLOWING UNITS:

RE2100: Control unit with integral receiver and exciter.

T2130: 250W PEP SSB transmitter with integral power supply for RE2100. Supply voltage 24V.

AT2110: 250W PEP aerial coupler for use outdoors.

N2160: 12V DC power supply for T2130.

N2161: 110/220/240V AC, 50 Hz power supply for T2130.
1 INTRODUCTION

1.1 GENERAL DESCRIPTION

SAILOR HF SSB AT2110 is a 250W PEP aerial coupler.

SAILOR HF SSB AT2110 is able to tune aerials from 7 to 15 metres.

SAILOR HF SSB AT2110 is able to tune in the entire frequency range from 1.6 MHz to 30 MHz.

SAILOR HF SSB AT2110 has a waterproof cabinet.

SAILOR HF SSB AT2110 has a high reliability due to few active components.

SAILOR HF SSB AT2110 tunes automatically, controlled from the microprocessor in T2130.

SAILOR HF SSB AT2110 tunes typically for less than 2 secs.

SAILOR HF SSB AT2110 has small dimensions and low weight.
1.2 TECHNICAL DATA
(complies with SOLAS, ITU, CEPT, MPT, DOC, FTZ, KSR, FCC)

GENERAL

Frequency Range: Receiver: 100 kHz to 30 MHz
Transmitter: 1.6 MHz to 30 MHz

Modes: J3E (USB/LSB), R3E and H3E (AM)

Channel Capacity: 100 user defined quick-select channels and ITU defined channels in the maritime bands. Each channel contains both RX and TX frequency and mode settings.

Scanning Facilities: 10 scanning programmes, each able to contain 128 pairs of frequencies.

Distress Call: Quick selection of 2182 kHz
Built-in two tone alarm: 1300 Hz and 2200 Hz with a duration of 45 secs.

Operating Temperature Range: -15°C to +55°C

Frequency Stability: Better than 0.34 ppm

Primary Voltage: 24V DC - 10% +30%

Current Drain: Receiver (standby) 0.9A
Transmit voice 7A
Transmit two-tone 13A

Aerials: from 7 - 15 m

TRANSMITTER T2130

Power Output: 250W PEP ± 1.4 dB (T2130/I 240W PEP max.)

Intermodulation: better than 32 dB below PEP

Spurious Emission: better than 67 dB below PEP

Harmonics: better than 43 dB below PEP or better than 67 dB below PEP with aerial coupler AT2110

Carrier Suppression: better than 46 dB below PEP

Audio Response: 350 Hz to 2700 Hz at -6 dB

RECEIVER RE2100

Receive System: Double conversion super heterodyne
1st IF 70 MHz. 2nd 10.73 MHz

Selectivity: J3E (SSB) 350 Hz to 2700 Hz at -6 dB
H3E (AM) ±3.3 kHz at -6 dB
1 INTRODUCTION

Sensitivity: J3E (SSB) <10 dB/uV for 20 dB SINAD
H3E (AM) <24 dB/uV for 20 dB SINAD

Spurious and IF Rejection: better than -70 dB

Cross Modulation: better than 90 dB/uV (CEPT method of test)

Desensitization: better than 100 dB/uV (CEPT method of test)

AGC: less than 2 dB audio level change from 10 dB/uV to 80 dB/uV. Fast attack, slow release time.

Intermodulation: better than 90 dB/uV (CEPT method of test)

Spurious Emission: better than 1 nW into dummy aerial

Clarifier: ±150 Hz in steps of 10 Hz

Squelch: Voice activated, opens for SINAD >6 dB

Audio Power: 5 Watt, 8 ohm, less than 10% distortion
10 Watt, 4 ohm, less than 10% distortion

AERIAL COUPLER AT2110

Power: 250W PEP
Aerials: 7 - 15m
Temperature Range: -25°C to +70°C
Tuning Time: Typically less than 2 secs (learn mode typ. 30 secs)

ACCESSORIES

Loudspeaker: H2054 see special brochure
H2074 see special brochure

Power Supplies: N2160
Input supply: 12V + 30% - 10%
For more information see the manual for N2160

N2161
Input supply: 110V - 127V - 220V - 240VAC
Input frequency: 50 - 60 Hz
For more information see the manual for N2161

Weight: RE2100: 4.5 kg
T2130: 14.0 kg
AT2110: 4.5 kg
1.3 PRINCIPLE OF OPERATION AND BLOCK DIAGRAM

SAILOR Compact HF SSB AT2110 is a 250W PEP aerial coupler in SAILOR Compact HF SSB Programme 2000. It contains the following circuits.

CONNECTION AND INTERFACE UNIT
This unit contains a bus receiver, specially constructed to work in noisy environments. The bus receiver is followed by a detector/latch and shift registers, which controls the relay drivers.

MAIN BOARD
This unit contains the components for the aerial matching. It also contains the aerial current detector. The RF signal from the transmitter T2130 is fed to a transformer, and then through a serial inductor, which is variable in steps, in series with a motor driven variable capacitor. After the variable capacitor there is a shunt capacitor to ground. This capacitor is variable in steps. From here the signal is fed to the aerial relay and then through the aerial current detector circuit to the aerial.

BLOCK DIAGRAM AT2110
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2 INSTALLATION

2.1 MOUNTING POSSIBILITIES/DIMENSIONS AND DRILLING PLAN
Free Space for cable entry.
For cable installation remove the 4 screws marked * in the plug. The plug can be lowered 60mm to allow cable installation.
2.2 ELECTRICAL CONNECTION

(FOR CABLE SPECIFICATIONS SEE MANUAL T2130)

Cable mounting details in plug for AT 2110.
Cable installation:
When removing the 4 screws in the AT2110 plug, the plug can be lowered 60 mm to allow cable installation.
OBS. The plug cannot be removed from the AT2110 during installation.
The numbers on the supply terminal block at Connection and Interface PCB in AT2110 correspond with the numbers on the supply terminal block at the Connection Board PCB in T2130.

WIRE STRIPPING FOR TRIAXIALCABLE H1213

MULTICABLE: Max. diameter ø 14.5mm
Length: Type:
0 - 50m 10 x 0.5 mm²
50 -100m 10 x 1 mm²
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3 SERVICE

3.1 MAINTENANCE

PREVENTIVE MAINTENANCE
If SAILOR AT2110 has been installed in a proper way the maintenance can be reduced to an overhaul at each visit of the service staff. Then inspect the set, the antenna, cables, and plugs for mechanical damages, salt deposits, corrosion, and any foreign material. Owing to its traditional structure, the SAILOR AT2110 has a long lifetime, but it must always be carefully checked at intervals not exceeding 12 months - dependent on the conditions under which the set is working.

3.2 ALIGNMENT INSTRUCTIONS

INTRODUCTION
The measuring values indicated in chapter 5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS are typical values and as indicated it will be necessary to use instruments in absolute conformity with the below list:

3.3 PROPOSAL FOR NECESSARY MEASURING INSTRUMENTS

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<thead>
<tr>
<th>Instrument Type</th>
<th>Manufacturer</th>
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<td>Tone Generator type PM5107</td>
<td>PHILIPS</td>
</tr>
<tr>
<td>Electronic Multimeter type PM2505</td>
<td>PHILIPS</td>
</tr>
<tr>
<td>RF Directional Wattmeter Model 43</td>
<td>BIRD</td>
</tr>
<tr>
<td>Oscilloscope type PM3216</td>
<td>PHILIPS</td>
</tr>
<tr>
<td>Dummy load 50 ohm/250W</td>
<td>PHILIPS</td>
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<tr>
<td>Dummy Load 10 Ohm/250 pF</td>
<td>SAILOR H228</td>
</tr>
<tr>
<td>Power Supply 21-32V, 20A</td>
<td></td>
</tr>
</tbody>
</table>

3.4 TROUBLE SHOOTING

SAILOR Compact HF SSB system has built-in self-diagnostic service system, which is a great help in locating a fault.

When a fault is detected an error message will be displayed in the RE2100 display.

The following description will help you to find the defective unit or module.

Trouble-shooting should only be performed by persons with sufficient technical knowledge, who have the necessary measuring instruments at their disposal, and who have carefully studied the operation principles and structure of SAILOR AT2110.

The first thing to check is whether the fault is somewhere in the antenna circuit or power source.

When measuring in the units, short-circuits must be avoided as the transistors would then be spoiled.
LOCATING THE FAULTY MODULE

ERROR MESSAGES, DESCRIPTION
The error messages displayed in the RE2100 display are technically described in the following.

70. MOTOR CIRCUIT ERROR (AT2110)
An error is detected in the circuitry controlling the tune motor MO1 in the AT2110. The TX-processor has not detected the ‘180° pulse’ from the AT2110.

The error may be one of several possibilities:
If the tune motor MO1 starts running immediately after the power is switched on at the RE2100:

- Check the level of the ‘180° PULSE/AE-CURRENT’ at ST01 pin 3, on the Connection Board (6) in T2130.
  
  If the level is high (approx. 15 Volt):
  The error is probably in the AT2110:
  - Check the ‘180° PULSE/AE-CURRENT’ connection between T2130 and AT2110.
  - Check the ‘180° PULSE/AE-CURRENT’ connection in the AT2110.
  - Check the light in the optocoupler OC01 on the Main Board (1) in the AT2110. This may be done by measuring the voltage drop across the resistor R26 in the Connection and Interface module (3) in the AT2110.

  If the level is low:
  The error is probably in the T2130:
  - Check the ‘180° PULSE/AE-CURRENT’ connection between the Connection Board (6) and the TX-processor (3) in the T2130.

If the tune motor MO1 does NOT start running immediately after the power is switched on at the RE2100:

- Check the voltage at ST01 pin 7 when the power is tuned on at RE2100. The voltage should be approx. 16 Volt.

If the 16 Volt is ok:
The error is probably in the AT2110:

- Check the connection to the tune motor MO1 in AT2110.
- Check the ‘Motor +’ connection between the T2130 and the AT2110.

If the 16 Volt is NOT present:
The error is probably in the T2130:

- Check the connection between the TX-processor (3) and the Connection Board (6) in T2130.
3.4.1 REPLACEMENT OF COMPONENTS

When replacing transistors, diodes, resistors, capacitors and similar components you must use a small „pencil“ soldering iron of 30 to 75 Watt rating. The soldering must be performed rapidly to avoid overheating, and the use of a tin sucker is recommended, as otherwise there is a risk that both the components and the printed circuit will be spoiled.

3.4.2 REPLACEMENT OF MODULES

If a fault has been found in a module, it may often be worthwhile to replace it and then repair it later on.
3.5 PERFORMANCE CHECK

3.5.1 CHECK OF RELAYS

1. Select service programme SP-30-2. This will activate RE02 on module (1), see chapter 3.9.
2. Check the rest of the relays up to RE09.
3. Select service programme SP-31-0 and check the rest of the relays.

3.5.2 CHECK OF THE TUNE MOTOR

1. Select service programme SP-32-3.
2. Check if the motor is running at low speed.

3.5.3 CHECK OF C02 TO C06

1. Check by means of a capacitance measuring instrument that they have the correct values.

3.5.4 CHECK OF COIL L01

1. Check by means of an inductance measuring instrument that the total inductance is 58 uH.

3.5.5 CHECK OF COIL L02

1. Check that the total inductance is 7.5 uH.

3.5.6 CHECK OF THE RF SIGNAL

1. Connect the AT2110 to a dummy load 10 ohm in series with 250 pF. Select a frequency close to 2 MHz.
2. Key the transmitter by means of the handset key. Whistle into the microphone and check that the aerial current is more than 2 Amps.
3. Repeat point 2 on a 6 MHz frequency and check that the aerial current is more than 3 Amps.
4. Check in standby position that there is connection from the aerial feedthrough to the receiver for frequencies below 3.9 MHz and frequencies above 4.1 MHz.
3.6 FUNCTION CHECK

The function check is to be carried out when the installation is completed.

3.6.1 Check that it is possible to tune in all frequency bands (e.g. a high and a low frequency in each of the maritime bands). When doing this, use the functions <TX> and <TUNE>. When you have completed the check, make a test call to a coast station.

3.6.2 If it is not possible to tune on some frequencies, check the aerial and the surrounding rigs, for resonances or bad connections.
3.9 SERVICE PROGRAMMES

In the following it is assumed that the Service Programme jumper is inserted in the RE2100.
In general, if the RE2100 displays 'Err.0' in a Service Programme, the selected SP does not exist.

Example:

Operator: Key: 20-7 <ENT>
RE2100: Displays: ‘SP-20-7’
     ‘ Err.0’

Legend: Err.0 = The entered service programme does not exist.

SERVICE PROGRAMMES RELATED TO AT2110

SP-30
Activates AT2110 relays 1-9 one by one, and releases any relay.
Example:

Operator: Key: 30 - (0-9) <ENT>
RE2100: Displays: ‘SP-30-(0-9)’
     ‘ A. ’

Legend: 0 = No relays activated
1-9 = Relays 1-9 activated
A. = Accepted

The T2130 activates the entered AT2110 relay no., other relays are released.

SP-31
Activates AT2110 relays 10-19 one by one.
Example:

Operator: Key: 31 - (0-9) <ENT>
RE2100: Displays: ‘SP-31-(0-9)’
     ‘ A. ’

Legend: 0-9 = Relays 10-19 activated.
A. = Accepted.

The T2130 activates the entered AT2110 relay no., other relays are released.

If the AT2110 is in the systen (jumper 5 is inserted in the TX-processor) the following is displayed:

RE2100: Displays: ‘SP-25’
     ‘ Err.1’

SP-32-0
Resets the AT2110 ‘Clock’ line, ‘Data’ line and the ‘Motor +’ line to their normal state.
Example:

Operator: Key: 32 - 0 <ENT>
RE2100: Displays: ‘SP-32-0’
     ‘ A. ’
SP-32-1
Sets the AT2110 clock line high.
Example:

Operator: Key: 32 - 1 <ENT>
RE2100: Displays: 'SP-32-1'
    A. '

SP-32-2
Sets the AT2110 data line high.
Example:

Operator: Key: 32 - 2 <ENT>
RE2100: Displays: 'SP-32-2'
    A. '

SP-32-3
Sets supply on the AT2110 'Motor +' line, (low speed).
Example:

Operator: Key: 32 - 3 <ENT>
RE2100: Displays: 'SP-32-3'
    A. '
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4 MECHANICAL DISASSEMBLING

4.1 MECHANICAL DISASSEMBLING AND MODULE LOCATION

1) Remove 2 x allan screws.

2) Remove aerial connector by unscrewing it.

Remove 16 x screws

Bottom View

Main Board (Module 1)

Connection and Interface (Module 3)
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5  CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS

5.1 MAIN BOARD (MODULE 1) PART NO. 625651

This board contains all circuits necessary to make match between the aerial impedance and the transmitter output impedance.

In receive mode the signal is fed direct to the aerial via RE18, RE17, and RE16 for frequencies above 4 MHz. For frequencies below 4 MHz, RE17 is activated so that the aerial is fed through TR03 to the receiver. TR03 is transforming the aerial impedance down to give better match to the receiver.

In transmit mode the signal from the transmitter is fed to TR01, which transforms the impedance down to 12.5 ohm. From TR01 the signal is fed to L01 and L02. The value of the coils is set by the relays RE01 and RE10. The relays are controlled from the TX processor in T2130. From the coils the signal is fed to C01, a variable capacitor which is driven by the motor MO01. MO01 is controlled from the TX processor in T2130.

The optocoupler OC01 gives a pulse for every 180° rotation of the capacitor C01. This pulse is fed to the TX processor in T2130. From the variable capacitor C01 the signal is fed to a shunt capacitor bank. The value is selected by RE11 to RE15, which is controlled from the TX processor in T2130. From the capacitor bank the signal is fed through TR02, which is a current transformer. The output from TR02 is rectified in D01 and the DC output is fed to the TX processor in T2130.

From TR02 the signal is fed to the aerial relay RE16. GL01 is protecting the aerial coupler against small lightnings. R02 is discharging the aerial.
View from component side with upper side tracks.

View from component side with lower side tracks.

PCB rev. 25651J
This diagram is valid for PCB rev. 25651H
5.3 CONNECTION AND INTERFACE UNIT (MODULE 3) PART NO. 625653

TECHNICAL DESCRIPTION
The Connection and Interface Board has the following main functions:

- receives data from the T2130
- activates the relays
- detects when manual tune is activated and activates specific relays

The circuit consists of the following subcircuits:

- PULSE SHAPING AND NOISE REDUCTION
- STROBE GENERATION
- POWER-UP RESET
- SHIFT REGISTERS
- RELAY DRIVERS
- MANUAL TUNE
- +5 VOLT REGULATOR

PULSE SHAPING AND NOISE REDUCTION
The board receives data synchronized. For every data bit is one separate clock bit.
There are two identical circuits for receiving and shaping clock and data pulses.
Each consists of a comparator U01 configurated as a Schmitt-trigger. The reference is determined by the zener diode D06 and the hysteresis is determined by R10, R12, R06, and R11, R13, R28 respectively. The lower trigger level is approximately 2.5 Volt and the upper trigger level is approximately 13.6 Volt.
To ensure a correct level for the following logic circuit, the Schmitt-triggers U03/04 and U03/01 (74HC14) are added.

STROBE GENERATION
To set data in the 3 serial to parallel shift registers, 24 clock pulses are necessary. 24 clock pulses and corresponding data are transmitted to the board twice with a certain period in between. In the following, reference is made to ‘Timing diagram for strobe generation’.
A strobe is generated when the board has received 24 clock pulses. The strobe is generated by use of a ripple counter U06 (74HC4024). When the outputs ‘Q4’ and ‘Q5’ (‘8’ and ‘16’) both go to high level, the shift registers are strobed, the new data is transferred to the relay drivers, and the corresponding relays are activated.
The monostable U05/01, A1 (pin 4) is triggered when the strobe goes high. The output of U05/01, Q1 (pin 6) goes high immediately and goes low after the time t1. The ripple counter U06 is reset after the time t1 and the second pulse train may be received. The reset pulse comes from the monostable U05/02 pin 10, which is triggered when the time t1 has passed. U05/01, Q1 (pin 6) goes back to the low state.
The double clock and data transfer ensures a high security for the correct data transfer. Only in the time t4 it is possible to introduce false clock pulses which may disturb the circuitry.
Figure 1: Timing diagram for strobe generation.

All times are in msecs. The parenthesis indicates how the time is determined.

- \( t_0 = 3.2 \) msecs (microprocessor)
- \( t_1 \text{ min.} = 2.93 \) msecs
- \( t_1 \text{ max.} = 3.78 \) msecs (R19, C15, 'K' from 74HC4538)
- \( t_2 \text{ approx.} = 0.01 \) msec. (R18, C14)
- \( t_3 = 4.0 \) msecs (microprocessor)
- \( t_4 \text{ max.} = 1.07 \) msec. (\( t_3 - t_1 \text{ max} \))
- \( t_4 \text{ min.} = 0.22 \) msec. (\( t_3 - t_1 \text{ min} \))

**POWER-UP RESET**
This circuit delivers a pulse to the monostable U05/02, pin 12 when the power supply comes up. The output of the monostable gives a reset pulse to the ripple counter so it is ready to receive the 24 clock pulses.

**SHIFT REGISTERS**
The serial to parallel shift registers U09, U08, U07 (74HC595) are cascaded. When the data has been clocked to the correct bits by the 24 clock pulses, the strobe activates the ‘Latch clock’ input (pin 12) and the data is latched to the output.

**RELAY DRIVERS**
The relay drivers consist of 19 (2 spares) open collector Darlington drivers, located in U10, U11, and U12 (MC1413/ULN2003). Input of the drivers are connected to the output from the shift registers U07, U08, U09.
The output of the drivers are connected to the corresponding 19 relays.
The relay RE01 is normally released as the ‘Date’ wire is held low by TX-processor (3) in the T2130.
MANUAL TUNE

When the 'Automatic/manual tune' switch on the Connection Board (6) in the T2130 is shifted to 'Manual Tune' two signals are changed.

Figure 2: Manual Tuning Overview.

The 'Manual Tune' wire (P01 pin 10 on the Connection Board (6) and P05 pin 10 on the TX-processor (3, T2130)) is set to 0 Volt. This tells the TX-processor (3, T2130) (and the RE2100) that a manual tune is to be done and tune tones are started.

The 'Data' wire (ST01 pin 6 in the Connection Board (6) in T2130) is interrupted. The 'Data' line is normally kept low (<+1 Volt) when no data is transferred to the AT2110. The 'Data' wire is shifting to a high state (approx. +21 Volt) by the resistor R03 on the Connection and Interface Board (3) in the AT2110. This permanent shift of the 'Data' wire is detected by the 'Manual Tune' circuit. The capacitor C51 is slowly charged by the resistor R22. The relay RE01 is activated when the voltage on the C51 has reached approximately 12 Volt. The transistors Q01 and Q03 form a Schmitt-trigger.

The activating of the relay RE01 disconnects the +21 for the U02, +5V supply for the logic. This means that all relays on the Main Board (1) are released from the drivers U10, U11, and U12.

The specific relays for tuning 2182 kHz are activated by the relay RE01 and the diodes D10 (RE19), D11 (RE17), D12 (RE08), D13 (RE02).

+5 VOLT REGULATOR

This regulator delivers the supply for the logic circuits on the Connection and Interface Board (3).

Part of 'Motor Control Circuitry'. This consists of the transistor Q02 and surrounding resistors R05, R25, R26. The transistor turns on the LED in the optocoupler OC01 on the Main Board (1) when supply voltage is applied to the tune motor MO1.
View from component side with upper side tracks.

View from component side with lower side tracks.

PCB rev. 25653H
This diagram is valid for PCB rev. 25653H
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## 6  PARTS LIST

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<th>MANUFACTURER</th>
<th>TYPE</th>
<th>PART NO.</th>
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<td>MANUAL AT2110</td>
<td>S.P.RADIO A/S</td>
<td>Ver.: M2110GB</td>
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### BASE UNIT AT2110  ECI A/S  702110

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### MAIN BOARD MODULE 1  AT2110  ECI A/S  5-0-25651J / 4-0-25651F  625651

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<td>POS. VOLTAGE REG. FIXED</td>
<td>MOTOROLA</td>
<td>MC78L05ACP RA</td>
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<td>U3-3</td>
<td>INVERTER w.SCHMIDT TRIGG.</td>
<td>TEXAS</td>
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<td>U4-3</td>
<td>QUAD 2-INP.PS.AND GATE</td>
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<td>U5-3</td>
<td>MONOSTAB.MULTI/8,DUAL</td>
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<td>COUNTER 7 STATE BIN.RIPP.</td>
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