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# MODEL NC802 VOICE <sup>plus</sup> INVERSION SCRAMBLER

## INSTRUCTION MANUAL

### INTRODUCTION

The Model NC802 is a micro-miniature voice-plus inversion scrambler designed to provide intermediate level security for two-way radio voice communication systems. The NC802 is a perfect, cost effective solution to entry-level voice scrambling for commercial users, police departments, public safety organizations and other systems, as a defense against unauthorized interception of private voice transmissions by casual listeners or business competition such as with taxi dispatching.

The NC802 provides single line or double tap of radio's Monitor switch for selection of scramble or clear modes, audible (speaker beep) and visual indication of mode selected, remote selection of 1 of 8 commonly used inversion carrier frequencies, low current operation and SMT assembly. Measuring 0.75"W x 1.23"L x 0.21"H, the NC802 is ideal for limited space applications such as in today's portable radios.

### OPERATION

The Model NC802 scrambles speech by transposing the inband voice spectrum with 1 of 8 user selectable inversion carriers. This process reverses the low and high frequency voice components, creating unintelligible sounds. Descrambling simply reverses the process. In the scrambled mode, the transmitted speech is modulated with a selected carrier frequency in the NC802 double balanced mixer. In the receiver, the NC802 once again mixes the received sound with the same selected carrier frequency, restoring clear speech. Operation is near transparent to the user in most applications and the selection of scrambled/clear modes is the only user control.

### SPECIFICATIONS

|                               |  |
|-------------------------------|--|
| FORMAT .....                  | Speech inversion.  |
| SECURITY LEVEL.....           | Intermediate.  |
| CODES .....                   | 8 carrier frequencies: 3107Hz, 3333Hz, 3500Hz,<br>3729Hz, 2632Hz, 3388Hz, 2868Hz and 2728Hz.                                       |
| MODES .....                   | User selectable for scrambled or clear.  |
| AUDIO RESPONSE .....          | 300Hz to 2800Hz.   |
| INPUT LEVEL .....             | Adjustable from 3.5 to 710mV-rms @ >50K ohms, D.C. blocked.  |
| OUTPUT LEVEL .....            | Adjustable from 3.5 to 710mV-rms @ <2K ohms, D.C. blocked.   |
| CARRIER SUPPRESSION .....     | 55dB or better.  |
| INVERSION PROGRAMMING .....   | 3 Leads, binary (8 codes).   |
| SCRAMBLE/CLEAR MODE.....      | [1] Single line active 'low' to enable/disable scramble mode.<br>[2] Double tap of Monitor switch to enable/disable scramble mode. |
| SCRAMBLE MODE INDICATORS..... | [1] Sourced output for LED (current limited).<br>[2] Audible (Beeps) speaker driver output.  |
| PTT INPUT .....               | Active 'low' to transmit.  |
| OPERATING VOLTAGE.....        | 5.5VDC to 16VDC.   |
| OPERATING CURRENT .....       | <5mA (Quiescent).  |
| OPERATING TEMPERATURE .....   | -30°C to +70°C.  |
| SIZE .....                    | 0.75"W x 1.23"L x 0.21"H<br>19.0mmW x 31.24mmL x 5.3mmH  |
| MOUNTING .....                | Double sided adhesive tape.  |
| INTERFACING .....             | Micro-miniature header and 12 inch Teflon color coded cable assembly.  |

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**SPECIFICATIONS ARE SUBJECT TO CHANGE IN THE INTEREST OF  
TECHNICAL IMPROVEMENT WITHOUT NOTICE OR OBLIGATION**

# INTERFACING

As supplied, the Model NC802 is fully adaptable for most applications. It is, however, recommended that before final installation and for optimum performance that installation be performed by a qualified technician using the correct test equipment and that both transmit and receive audio input levels to the NC802 be measured independently and, if necessary, that the correct gain setting resistors be installed. Refer to MIC and RX input interfacing procedures to determine input signal levels and selection of appropriate resistor values. The use of a service monitor with audio generator and an oscilloscope or A.C. rms voltmeter is required for these measurements. A piece of double sided adhesive tape is provided to eliminate the need for mounting hardware. When scrambler is ready for installation, remove protective covering from one side of tape and attach to the bottom side of P.C. board. Now remove protective cover from remaining side of tape and adhere scrambler to desired location, making sure that mounting surface is clean and dry to insure positive mounting. If possible, scrambler should be located away from intense R.F. fields and all leads be kept to minimum lengths, with unused leads removed from cable assembly. **NOTE: Refer to Figure 3 page 5 for typical circuit configuration before installation.**

- RED (2).....Connect to a +5.5 to 16VDC regulated D.C. source. Because both receiver and microphone low level audio passes through the NC802, it is very important to use a quiet and stable D.C. voltage to reduce the possibility of introducing power supply noise that would alter these audio signals.  
[+SUPPLY]
- BLACK (10) .....Connect to common TX and RX ground location. Power supply noise and ground loops may result in TX or RX audio stages if ground return is not common to both.  
[- SUPPLY]
- YELLOW (11) .....[METHOD 1] Connect this lead in series with a SPST switch to ground or to radio's software switch providing a logic 'LOW' (to ground) when programmed to enable scramble mode on a per-channel selection.  
[SCRAMBLE/CLEAR SELECT]  
(STANDARD MODE)
- YELLOW (11) .....[METHOD 2] Connect this lead to the radio's Monitor switch providing a momentary closure to ground when pushed. Solder bridge jumper JU3. This feature eliminates the need for a software or SPST switch sometimes not available in today's portable radios. Using this feature allows the user to toggle between scramble and clear modes by simply pushing the radio's monitor switch **TWO** times in rapid succession (Double tapping). The NC802 generates a 900 Hertz tone output to the radio speaker responding with **TWO** beeps to indicate selection of scramble mode and **ONE** long beep for clear mode. [Refer to Figure 2, page 4 for location of JU3].  
[SCRAMBLE/CLEAR SELECT]  
(DOUBLE TAP MODE)
- WHITE/GREEN (5) .....This output is current limited by a 1K ohm resistor and will source 2.5 volts at 3mA when in the scrambled mode. Connect this lead to the **ANODE** of a high efficiency 'LED' and the **CATHODE** of the 'LED' to ground.  
[SCRAMBLE MODE VISUAL INDICATOR] **NOTE:** For sinking (to ground), solder bridge jumper JU5 as shown in Figure 3 on page 5 under 'optional'. Many radios have spare indicators such as Busy, Monitor, Call Aux, Back lighting, etc. that can be used for this option. [Refer to Figure 3 page 5 for typical circuit configuration].
- GREEN (14) .....Connect this lead directly to the high side of radio speaker or to input of receiver's audio amplifier through a series resistor. The value of this resistor will have to be selected for desired audio output level.  
[AUDIBLE (BEEP) OUTPUT]
- BROWN (13) .....Connect this lead to transmit PTT circuitry that goes 'low' (to ground) during transmit mode.  
[PTT INPUT]
- BLUE (6).....Connect these two leads directly in series with the output of the receiver's discriminator circuitry for optimum recovered audio. In some cases, the removal of a resistor or coupling capacitor makes for an ideal circuit break point. To insure receiver audio quality, perform input level measurements and make sure that break point connections are **NOT** made between the discriminator and **CTCSS** or **SQUELCH** circuitry or any other type of decoder, if installed, and in a location so not to interrupt an internal D.C. bias voltage in the receiver's audio stages. **NOTE:** Because of filtering circuitry, both **CTCSS** and carrier **SQUELCH** signals will not pass through scrambler. **DTMF** and other in-band decoders may fail to function because of signal inversion and level changes. If it is necessary to connect to audio path after **CTCSS** decoder, make sure to bypass or disable the **CTCSS High Pass Filter** if used. The NC802 contains a high pass filter to filter out CTCSS tones. [Refer to Figure 3 page 5 for typical circuit configuration].  
[RX AUDIO INPUT]  
&  
ORANGE (3)  
[RX AUDIO OUTPUT]

## RX LEVEL TEST PROCEDURES:

To determine receiver input level, select clear mode and connect an oscilloscope or A.C. rms voltmeter to the solder junction of [RX AUDIO INPUT] BLUE LEAD (6) and circuit break point in discriminator. Using a service monitor, generate a full quieting signal modulated with a 1KHz tone at full system deviation then measure signal level. Use this measurement to select from "RX GAIN CHART" the appropriate resistor values for R1 and R6 [Refer to Figure 1 page 4 for location of R1 and R6]. **NOTE:** Verify that the [RX AUDIO OUTPUT] ORANGE LEAD (3) has near the same level measured at input.

| RX GAIN LEVEL CHART |                 |           |          |
|---------------------|-----------------|-----------|----------|
| INPUT<br>mV-P-P     | INPUT<br>mV-RMS | OUT<br>R1 | IN<br>R6 |
| 10-50               | 3.5-18          | 10K       | 10K      |
| 50-150              | 18-53           | 15K       | 15K      |
| 150-500             | 53-175          | 33K       | 33K      |
| 500-1000            | 175-350         | 82K       | 82K      |
| 1000-2000           | 350-710         | 200K      | 200K     |
| FACTORY SELECTED    |                 | 200K      | 200K     |

BLUE/WHITE (12).....Connect these two leads directly in series with the transmitter's microphone and modulator circuitry. Determine, first, if the microphone is D.C. biased by measuring for a voltage potential across the microphone element. If the microphone is D.C. biased, the leads must be connected between the bias circuitry and **FIRST** microphone

YELLOW/WHITE (1).....amplifier stage as the NC802 will not pass bias voltage. In some cases the removal of a resistor or coupling capacitor makes for an ideal circuit break point. To insure transmit audio quality, perform input level measurements and make sure that break point connections are made **BEFORE** the transmitter's **PRE-EMPHASIS** or **LIMITER** circuitry and in a location so as to **NOT** interrupt any internal D.C. bias voltage in the modulator audio stages.

[MIC AUDIO INPUT] .....[MIC AUDIO OUTPUT] .....

**[Refer to Figure 3 page 5 for typical circuit configuration.]**

#### MIC LEVEL TEST PROCEDURES:

To determine microphone input level, select clear mode and connect an oscilloscope or A.C. rms voltmeter to the solder junction of [MIC AUDIO INPUT] BLUE/WHITE INPUT LEAD (12) and circuit break point in modulator. Key transmitter and speak loudly into microphone or with an acoustically coupled 1KHz audio tone not exceeding 2/3 system deviation, then measure the signal level. Use this measurement to select from the "MIC GAIN LEVEL CHART" the appropriate resistor values for R2 and R5 [Refer to Figure 1 page 4 for location of R2 and R5]. **NOTE:** Verify that the [MIC AUDIO OUTPUT] YELLOW/WHITE LEAD (1) has near the same level measured at input.

| MIC GAIN LEVEL CHART    |                 |            |            |
|-------------------------|-----------------|------------|------------|
| INPUT<br>mV-P-P         | INPUT<br>mV-RMS | OUT<br>R2  | IN<br>R5   |
| 10-50                   | 3.5-18          | 10K        | 10K        |
| 50-150                  | 18-53           | 15K        | 15K        |
| 150-500                 | 53-175          | 33K        | 33K        |
| 500-1000                | 175-350         | 82K        | 82K        |
| 1000-2000               | 350-710         | 200K       | 200K       |
| <b>FACTORY SELECTED</b> |                 | <b>15K</b> | <b>15K</b> |

GRAY (8).....These inputs are used to select one of eight codes. If all inputs are left unconnected (ungrounded), code one [3.107KHz] is defaulted. Selection of the seven alternate codes is performed by the appropriate solder bridge jumpering of pads JU1, JU2 and JU4 or by use of a binary coded switch connected to the gray, white and violet leads of cable assembly. [Refer to Figure 2 page 5 for location of jumper pads.]

[BINARY CODE SELECT (JU1)]

WHITE (9)

[BINARY CODE SELECT (JU2)]

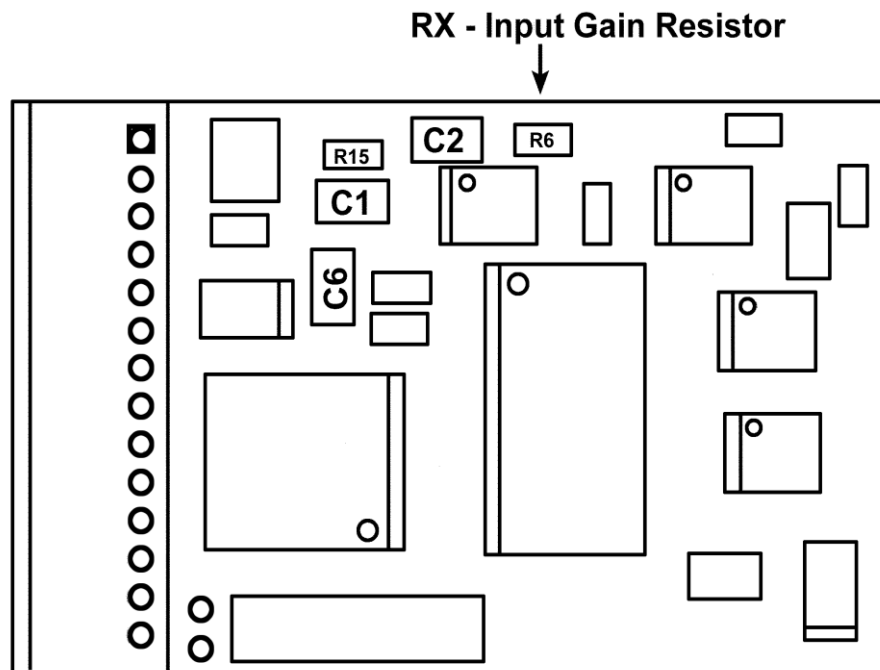
VIOLET (7)

[BINARY CODE SELECT (JU4)]

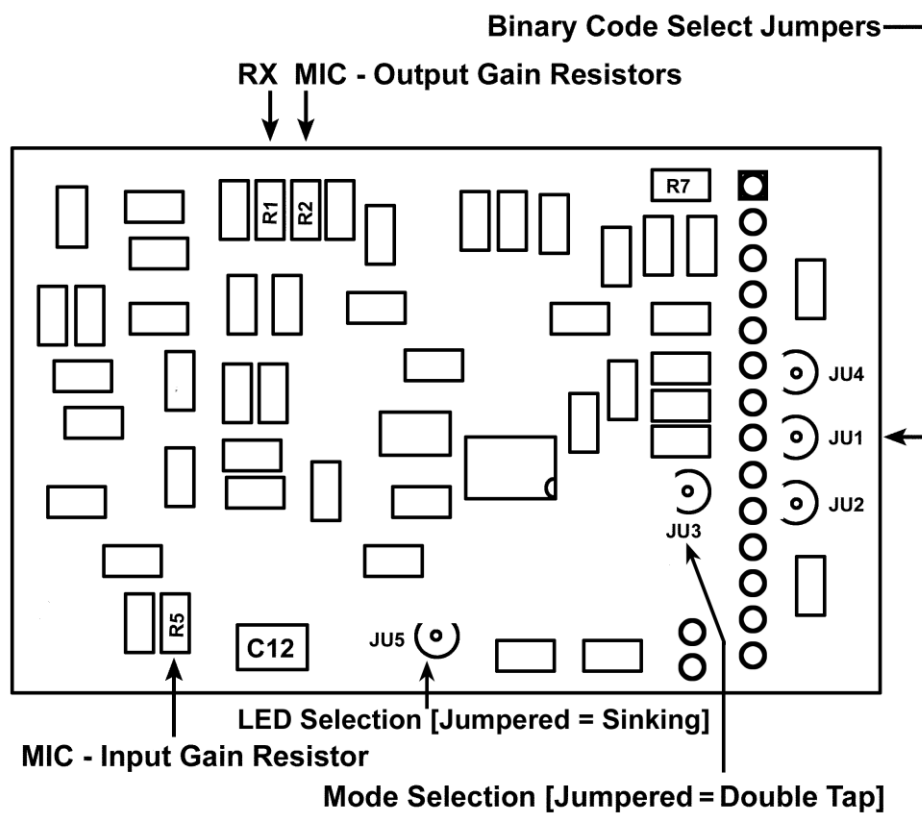
| <u>LEGEND</u>        |
|----------------------|
| MOT = Motorola       |
| ST = Selectone Inc.  |
| MX = MX-COM Inc.     |
| TS = Transcript Ltd. |
| KW = Kenwood         |

| CODE SELECTION CHART |     |     |     | 1 = LEAD NOT GROUNDED | 0 = LEAD GROUNDED |
|----------------------|-----|-----|-----|-----------------------|-------------------|
| CODE                 | JU1 | JU2 | JU4 | CARRIER FREQ          | COMP              |
| 1                    | 1   | 1   | 1   | 3107Hz                | -                 |
| 2                    | 0   | 1   | 1   | 3333Hz                | MX                |
| 3                    | 1   | 0   | 1   | 3500Hz                | MOT               |
| 4                    | 0   | 0   | 1   | 3729Hz                | ST                |
| 5                    | 1   | 1   | 0   | 2632Hz                | ST                |
| 6                    | 0   | 1   | 0   | 3388Hz                | KW                |
| 7                    | 1   | 0   | 0   | 2868Hz                | ST                |
| 8                    | 0   | 0   | 0   | 2728Hz                | TS/ST             |

**PCB TOP VIEW**  
**FIGURE 1**

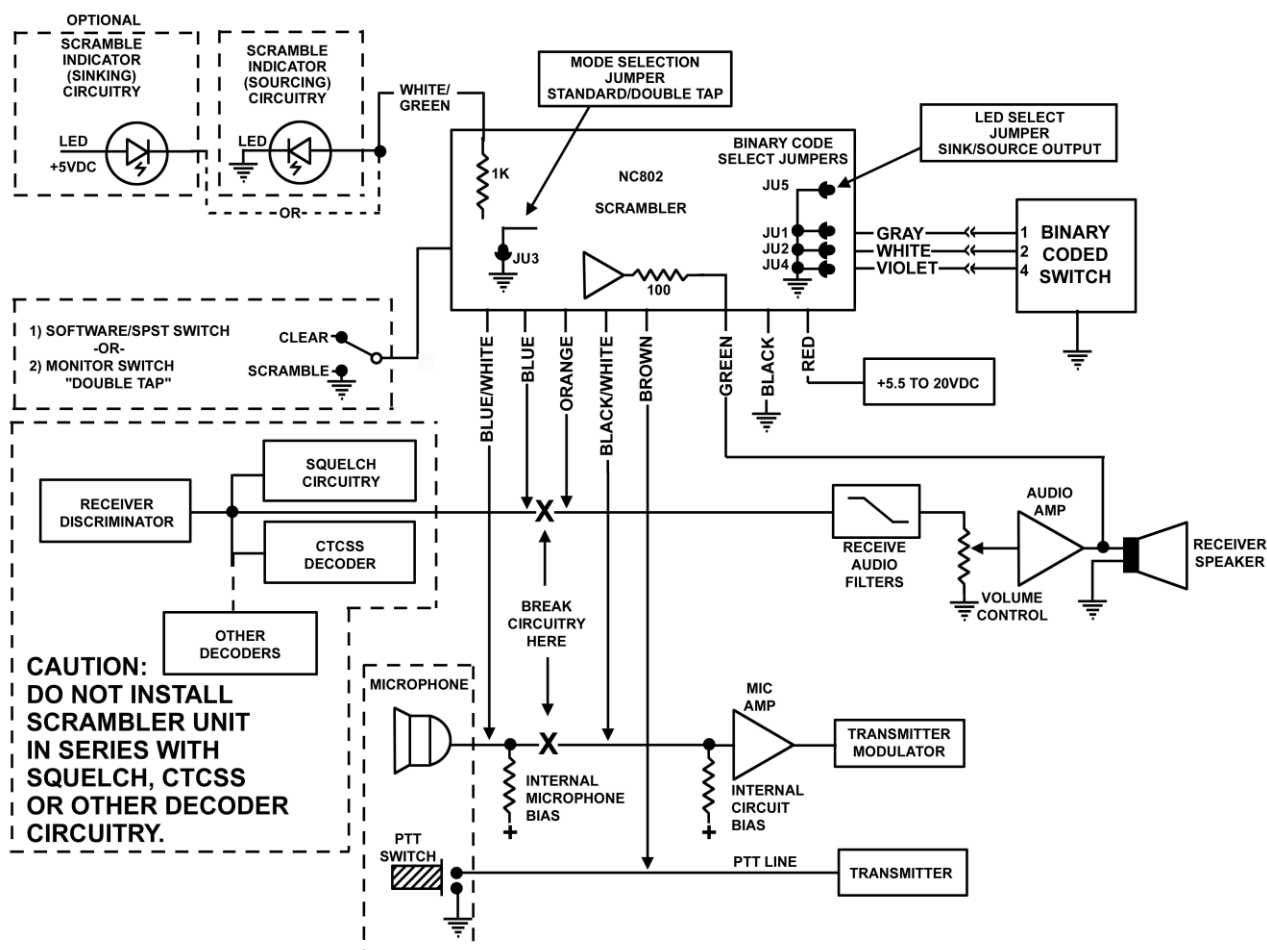


**PCB BOTTOM VIEW**  
**FIGURE 2**

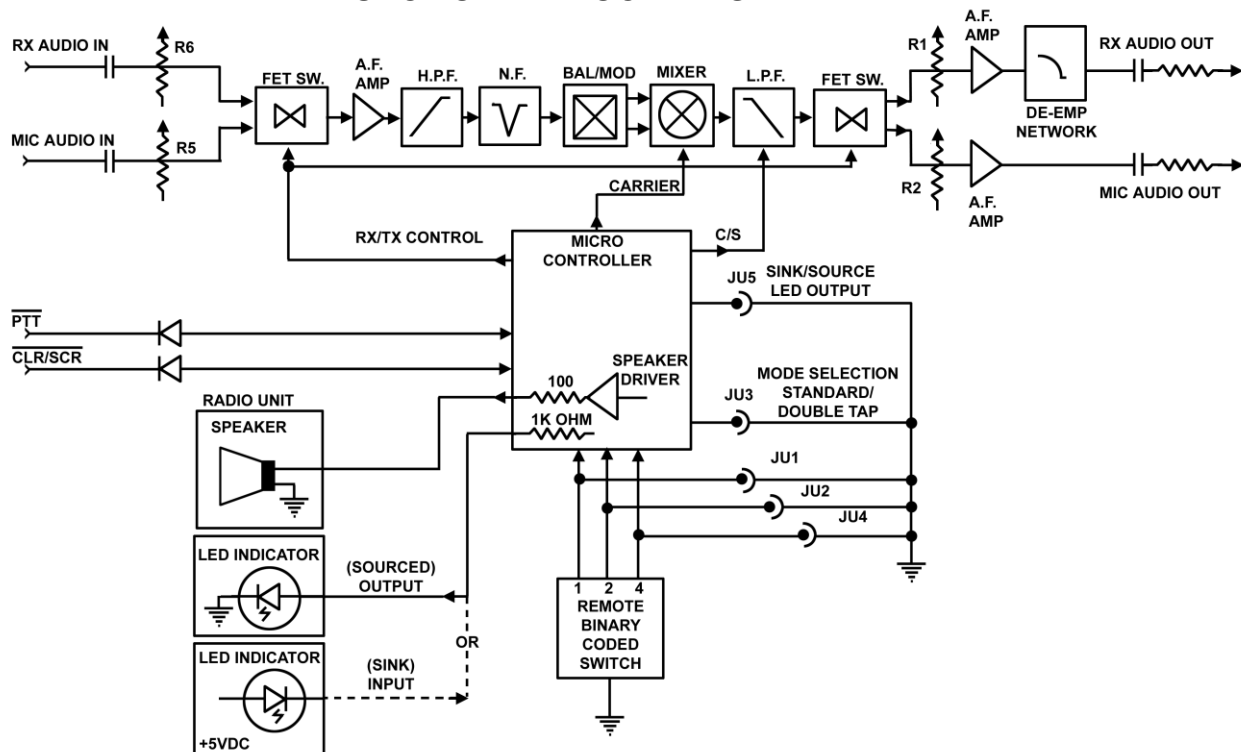


## TYPICAL CIRCUIT CONFIGURATION

FIGURE 3



## FUNCTIONAL BLOCK DIAGRAM



## **WARRANTY POLICY**

NorComm products are unconditionally guaranteed for two (2) years on materials and labor from date of purchase.

All Warranty repairs must be performed at NorComm's Customer Service Department in Grass Valley, CA. Units under warranty can be returned for repair or replacement without prior authorization, however, a letter explaining the defect should be enclosed with the unit. Out of warranty units returned constitute Purchaser's authorization for NorComm to repair or replace equipment and to invoice Purchaser for any and all reasonable costs of repair labor, parts and freight.

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