

Model GT-200

Operations Manual

Two Channel DIP Switch Programmable Inductive Loop Vehicle
Detector

This manual contains technical information for the
Model GT-200 Loop Detector

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Model GT-200 Operations Manual

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Section 1 General Description

This Operation Manual was written for people installing, operating, and troubleshooting Reno A & E Model GT-200 Series inductive loop vehicle detectors. The Model GT-200 is a scanning, two channel, card rack type loop detector designed to meet or exceed NEMA Standards TS 2-1998 and is downward compatible to NEMA Standards TS 1-1989.

The Model GT-200 uses a microcontroller to monitor and process signals from two separate loop / lead-in circuits. The operation of each channel is independently programmed with a front panel mounted eight-position DIP switch module to provide the following selections:

- Eight Sensitivity Levels (- Δ L/L %).
- Presence or Pulse Mode.
- Fail-Safe or Fail-Secure operation in a loop fail condition.
- Four Frequency Selections.
- Channel Disable.

The Model GT-200 also includes provision for Call Delay, Call Extension, and Phase Green Inputs. Delay and extension times are controlled by four PC board mounted six-position DIP switch modules to provide delay timing intervals of 0 to 63 seconds and extension timing intervals of 0 to 15.75 seconds. An active low state (0 to 8 VDC) on either channel's Phase Green Input will inhibit any Delay time for that channel. Extension time is not inhibited. The Fail-Safe / Fail-Secure DIP switch selects the channel output state as CALL or NO CALL during a loop failure condition. The Fail-Safe selection, which is the standard for intersection control, generates a continuous CALL output state for as long as a loop failure condition exists. The Fail-Secure selection generates a NO CALL output state during a loop failure condition. For traffic control applications such as incident detection, Fail-Secure operation is preferred because a constant CALL from a failed loop appears as though the traffic movement has stopped. The Fail-Secure selection also selects faster response times for very accurate speed measurement. The switch selection allows the user to set the detector operation to suit the particular application.

The Model GT-200 alternately excites the two loop circuits. This eliminates the possibility of adjacent loop fields coupling together (crosstalk) when the loops are connected to the same detector. Each time the loop circuit is activated, loop data is obtained and recorded. The data is compared to previous samples for both the amount and rate of change. A slow rate of change, as is the case with environmental drift, is continuously tracked. If a rapid change exceeds a threshold set by the sensitivity level, the output is activated.

Each channel has a single, dual color (green / red) Detect / Fail LED indicator. The LED provides an indication of the channel's output state, delay and/or extension timing settings, and loop failure conditions. Output state conditions are indicated when the Detect / Fail LED is illuminated in a green state. Loop failure conditions are indicated when the Detect / Fail LED is illuminated in a red state.

If the total inductance of the loop input network goes out of the range specified for the detector, or rapidly changes by more than $\pm 25\%$, the channel will enter the programmed Fail-Safe or Fail-Secure mode of operation. The Detect / Fail LED will illuminate (red) to indicate that an Open Loop Failure or an inductance change condition of greater than $+25\%$ exists. The Detect / Fail LED will flash (red) at a one Hz rate to indicate a Shorted Loop Failure or an inductance change condition of greater than -25% exists. Either indication will continue for as long as the loop failure exists. If the loop self-heals, the channel will resume operation in a normal manner, except the Detect / Fail LED will flash (red) at a rate of three 50 millisecond flashes per second, thus providing an alert that a loop fail condition has occurred. Any prior loop failure indication will continue until the detector is manually reset or power is removed.

The Detect / Fail LED will illuminate (green) to indicate a vehicle presence in the loop area. If a prior Loop Failure condition has occurred and detection occurs, the Detect / Fail LED will flash (red) at a rate of three 50 millisecond flashes per second followed by a single 750 millisecond flash (green). This prior Loop Failure indication will continue until the detector is manually reset or power is removed.

The Model GT-200 has TS 2 channel status outputs to communicate the status states of the loop and detector channel.

In addition, the Reno A & E Model GT-200 has a Test Mode that uses the microcontroller to verify the proper operation of the detector's controls and indicators (switches and LEDs). Each channel's loop oscillator circuit can also be tested to verify the correct frequency range in each of the four frequency selections.

The Model GT-200 Series is comprised of the following detectors:

- | | |
|-----------------|--|
| Model GT-200-R | For applications calling for a two channel, NEMA TS 2 rack mount detector with delay and extension timing and relay outputs. |
| Model GT-200-SS | For applications calling for a two channel, NEMA TS 2 rack mount detector with delay and extension timing and solid state outputs. |

Section 2 General Characteristics

2.1 DISABLE CHANNEL

Each detector channel can be disabled by setting DIP switch 1 to the **ON** position. When set to the **ON** position, the channel output is continuously in the NO CALL state regardless of the presence or absence of vehicles over the loop. The loop oscillator is not activated when the channel is in the Disabled State.

NOTE: Changing the Disable Channel switch setting of an individual channel will RESET that channel.

2.2 LOOP FREQUENCY

There are four (4) selectable loop frequency settings (normally in the range of 20 to 100 kilohertz) for each channel. The actual loop operating frequency is a function of the loop / lead-in network and the components of the loop oscillator circuit. Adjacent loops connected to different detectors may crosstalk and require changing of the operating frequency of one of the loop circuits. If crosstalk is a problem, select another loop frequency for stable operation. The four frequency selections for each channel are controlled with two DIP switches marked 2 and 3.

NOTE: The detector channel must be RESET after changing the frequency setting.

2.3 FAIL-SAFE / FAIL-SECURE

Fail-Safe or Fail-Secure mode of operation is selectable for each channel using DIP switch 4.

During a loop failure condition, the state of the channel's output can be selected as **CALL** in the Fail-Safe mode of operation or **NO CALL** in the Fail-Secure mode of operation. Fail-Safe operation during a loop failure is the standard operation for intersection control. Fail-Secure operation during a loop failure is typically used for incident detection systems for freeway management. The Fail-Secure selection also selects fast response for very accurate speed and occupancy measurements (see Response Time in Section 3.3).

NOTE: Changing the Fail-Safe / Fail-Secure switch setting of an individual channel will RESET that channel.

2.4 PRESENCE / PULSE MODE

Two modes of operation for each detector channel are available. Presence or Pulse Mode is selected by setting the state of DIP switch 5.

PRESENCE MODE: Provides a Call hold time of at least four minutes (regardless of vehicle size) and typically one to three hours for an automobile or truck. This is the factory default setting and the most common setting.

A minimum 100 ms presence output time can be selected by setting DIP switch 2 of SW3 (located near the upper right corner of the PC board) to the **ON** position. In the **OFF** position, the presence time reflects the actual time the vehicle is over the loop.

PULSE MODE: An output Pulse of 125 ± 10 milliseconds duration is generated for each vehicle entering the loop detection zone. Each detected vehicle is instantly tuned out if it remains in the loop detection zone longer than two seconds. This enables detection of subsequent vehicles entering the loop detection zone. After each vehicle leaves the loop detection zone, the channel resumes full sensitivity within one second.

NOTE: Changing the Presence / Pulse switch setting of an individual channel will RESET that channel.

2.5 SENSITIVITY

There are eight (8) selectable sensitivity levels for each channel. The sensitivity levels are designed so that a one level increase actually doubles the sensitivity and a one level decrease halves the sensitivity. The eight sensitivity levels are selected with three DIP switches marked 6, 7, and 8 for each channel.

NOTE: Changing the sensitivity level setting of an individual channel will RESET that channel.

2.6 CALL DELAY

Each channel's Call Delay can be adjusted from 0 to 63 seconds in one-second steps. Call Delay time starts counting down when a vehicle first enters the loop detection zone. If the Call Delay feature is activated, the output will only be turned on after the selected delay time has passed with a vehicle continuously present in the loop detection area. If a vehicle leaves the loop detection area during the delay interval, detection is aborted and the next vehicle to enter the loop detection area will initiate a new full delay interval. Whenever a channel's Phase Green Input (call delay override) signal (edge card connector contacts 1 or 2) is active (low state), the Call Delay function for that channel is aborted and the Call delay time is forced to zero. The detector indicates that a vehicle is being detected, but that the outputs are being delayed, by flashing the Detect / Fail LED at four Hz (green) with a 50% duty cycle. When operating in Pulse Mode, the 125 millisecond pulse output will be delayed by the amount of time programmed into the Delay timer.

2.7 CALL EXTENSION

Each channel's Call Extension can be adjusted from 0 to 15.75 in 0.25-second steps. Call Extension time starts counting down when the last vehicle leaves the loop detection zone. In the event a vehicle enters the loop detection zone before the extension time expires, the detector will return to the detect state (regardless of the setting of the delay timer) and the extension timer will be reset. When the last vehicle leaves the loop detection zone, full extension time is reestablished and the detector begins counting down again. The detector will indicate that the extension interval is currently timing by flashing the Detect /Fail LED at 16 Hz (green) with a 50% duty cycle. When operating in Pulse Mode, the 125 millisecond pulse output will be extended by the amount of time programmed into the Extension timer.

2.8 100 MS MINIMUM OUTPUT

When the detector is operating in Presence Mode, two modes of operation are available for the CALL outputs. Normal mode or 100 ms Minimum Output mode is selected via a DIP switch on a two-position DIP switch module located on the PC board. When this feature is OFF, CALL outputs will stay on only as long as the detection zone is occupied. When this feature is ON, every CALL output will have a minimum duration of 100 ms.

2.9 AUDIBLE DETECT SIGNAL

A front panel mounted push button labeled **BZZZER** is used to enable an audible detect signal that is emitted any time a given channel's detection zone is occupied. The audible signal indicates actual occupancy of the loop detection zone. Timing functions have no effect on the audible signal. This feature allows a technician to watch the detection zone on the street and confirm correct detector operation without having to look at the detector front panel LEDs as well. To activate this feature, press the push button. Only one channel can have this feature active at any given time. The first time the push button is pressed, a short (50 millisecond) audible signal confirms the activation of the feature for Channel 1. The second time the push button is pressed, two short (50 millisecond) audible signals confirm the activation of the feature for Channel 2. To deactivate this feature, press and hold the push button for one second. A long (250 millisecond) audible signal confirms the deactivation of the feature. This feature will automatically turn off 15 minutes after activation.

NOTE: When operating in Pulse Mode, the audible detect signal will cease if a vehicle occupies the detection zone for more than two seconds.

Section 3 Specifications

3.1 PHYSICAL

WEIGHT: 6.0 oz (170 gm).

SIZE: 4.50 inches (11.43 cm) high x 1.2 inches (3.05 cm) wide x 6.875 inches (17.46 cm) long including connector (not including front handle). Handle adds 1.00 inch (2.54 cm) to depth measurement.

OPERATING TEMPERATURE: -40° F to +180° F (-40° C to +82° C).

CIRCUIT BOARD: Printed circuit boards are 0.062 inch thick FR4 material with 2 oz. copper on both sides and plated through holes. Circuit board and components are conformal coated with polyurethane.

CONNECTOR: 2 x 22 contact edge card connector with 0.156 inch (0.396 cm) contact centers. Key slots located between B/2 & C/3, M/11 & N/12, and E/5 & F/6. See Section 3.6 for pin assignments.

3.2 ELECTRICAL

POWER: 10.8 to 30 VDC. Solid State output version - 100 milliamps maximum. Relay version - 130 milliamps maximum.

LOOP INDUCTANCE RANGE: 20 to 2000 microhenries with a Q factor of 5 or greater.

LOOP INPUTS: Transformer isolated. The minimum capacitance added by the detector is 0.068 microfarad.

LIGHTNING PROTECTION: The detector can tolerate, without damage, a 10 microfarad capacitor charged to 2,000 volts being discharged directly into the loop input terminals, or a 10 microfarad capacitor charged to 2,000 volts being discharged between either loop terminal and earth ground.

RESET: Each detector channel can be manually reset by momentarily changing any switch position (except the frequency switches or delay / extension switches). The detector can be reset by connecting a logic ground signal to Contact C of the edge card connector or by the return of power after a power loss.

RELAY RATING: The relay contacts are rated for 6 Amps maximum, 150 VDC maximum, and 180 Watts maximum switched power.

SOLID STATE OUTPUT RATING: Optically isolated. 30 VDC max. collector (drain) to emitter (source). 50 mA max. saturation current. 2 VDC max. transistor saturation voltage. The output is protected with a 33-volt Zener diode connected between the collector (drain) and emitter (source).

3.3 OPERATIONAL

DETECT / FAIL INDICATORS: The detector has one super bright, high intensity, two color (green / red) light emitting diode (LED) per channel to indicate a CALL output and/or the status of any current or prior loop failure conditions. A continuous ON (green) state indicates a CALL output. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% exists. This indication also generates a CALL output if the channel is set to operate in Fail-Safe Mode. If set to operate in Fail-Secure Mode, a CALL output is not generated. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% exists. This indication also generates a CALL output if the channel is set to operate in Fail-Safe Mode. If set to operate in Fail-Secure Mode, a CALL output is not generated. A flash rate of three 50 millisecond (red) pulses indicates a prior loop failure condition. A flash rate of three 50 millisecond (red) pulses followed by a single 750 millisecond (green) pulse indicates a prior loop failure condition and a current CALL output (detect state).

If either channel has the audible detect feature activated, that channel's Detect / Fail LED will be illuminated in an orange state for any CALL output condition.

Detect / Fail LED	Meaning
OFF	No Detect / No Loop Failure Condition (No CALL Output)
Solid ON (Green)	Detect (CALL Output)
Solid ON (Orange)	Audible Detect Signal Activated Detect (CALL Output)
Four flashes per second (Green)	Vehicle detected Delay Timing active No Detect (No CALL Output)
Four flashes per second (Orange)	Audible Detect Signal Activated Vehicle detected Delay Timing active No Detect (No CALL Output)
16 flashes per second (Green)	Detection zone vacant Extension Timing active Detect (CALL Output)
Solid ON (Red)	Open Loop Failure or Inductance change condition of greater than +25% exists
One Hz flash rate (Red) (50% Duty Cycle)	Shorted Loop Failure or Inductance change condition of greater than -25% exists
Three 50 ms (Red) flashes per second	Loop Failure condition occurred but no longer exists

Detect / Fail LED	Meaning
Three 50 ms (Red) flashes per second followed by single 750 ms (Green) flash	Loop Failure condition occurred but no longer exists and Detect (CALL Output)
Three 50 ms (Red) flashes per second followed by single 750 ms (Orange) flash	Loop Failure condition occurred but no longer exists Audible Detect Signal Activated and Detect (CALL Output)
Three 50 ms (Red) flashes per second followed by four flashes per second (Green)	Loop Failure condition occurred but no longer exists And Vehicle detected Delay Timing active No Detect (No CALL Output)
Three 50 ms (Red) flashes per second followed by four flashes per second (Orange)	Loop Failure condition occurred but no longer exists Audible Detect Signal Activated And Vehicle detected Delay Timing active No Detect (No CALL Output)
Three 50 ms (Red) flashes per second followed by 16 flashes per second (Green)	Loop Failure condition occurred but no longer exists And Detection zone vacant Extension Timing active Detect (CALL Output)

RESPONSE TIME: Meets or exceeds NEMA TS 2-1998 response time specifications. Actual response times of either channel depend on the sensitivity level setting and Fail-Safe / Fail-Secure selection of that channel. When set to operate in Fail-Safe Mode, response time is 65 ms \pm 25 ms for all sensitivity levels. When set to operate in Fail-Secure Mode, Fast Response is selected. The response time varies and depends on the sensitivity level selected. See Table: *Sensitivity, - Δ /L, and Response Times* for actual response times.

SELF-TUNING: The detector automatically tunes and is operational within two seconds after application of power or after being reset. Full sensitivity and hold time requires 30 seconds of operation.

ENVIRONMENTAL AND TRACKING: The detector is fully self-compensating for environmental changes and loop drift over the full temperature range and the entire loop inductance range.

GROUNDING LOOP OPERATION: The loop isolation transformer allows operation with poor quality loops (which may include one short to ground at a single point).

LOOP FEEDER LENGTH: Up to 5000 feet (1500m.) maximum with proper feeder cable and appropriate loops.

LOOP (FAIL) MONITOR: If the total inductance of the channel's loop input network goes out of the range specified for the detector, or rapidly changes by more than \pm 25%, the channel will immediately enter the programmed Fail-Safe or Fail-Secure mode of operation. The Fail-Safe mode of operation generates a continuous call during the loop failure. The Fail-Secure mode of operation does not generate a continuous call during the loop failure. The Detect / Fail LED will provide an indication to identify the type of loop failure condition that exists. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% exists. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% exists. This will continue as long as the loop fault exists. **However, if the detector is reset, or power is momentarily lost, the detector will return if the loop inductance is within the acceptable range. If any type of loop failure occurs in one (or more) loop(s) in a group of two or more loops wired in parallel, the detector will not respond with a Fail-Safe output following any type of reset. It is essential that multiple loops wired to a common detector channel always be wired in series to ensure Fail-Safe operation under all circumstances.** If the loop self-heals, the detector will resume operation in a normal manner except that the Detect / Fail LED will begin to flash at a rate of three 50 millisecond (red) flashes per second, thus providing an alert that the detector has experienced a prior loop failure condition. During this state, the Detect / Fail LED will also illuminate for 750 milliseconds (green) for a CALL output. The Detect / Fail LED will continue this display pattern indicating the prior loop failure condition and/or detect state until the detector is manually reset or power is removed.

FAIL-SAFE OUTPUTS: Per NEMA TS 2-1998. A detection output (CALL) is indicated by a conducting state. When operating in Fail-Safe Mode, a channel's output defaults to a CALL state for any loop failure condition on that channel. When operating in Fail-Secure Mode, a channel's output defaults to a NO CALL state for any loop failure condition on that channel. In either Fail-Safe or Fail-Secure Mode, a channel's output defaults to a CALL state upon loss of power.

CHANNEL STATUS OUTPUTS: Per NEMA TS 2. Each channel has an output LED that communicates the status states of the channel as follows:

State	Output
Normal operation	Continuous Low or On State
Detector failure	Continuous High or Off State
Open loop	50 millisecond On time, 50 millisecond Off time
Shorted loop	50 millisecond On time, 100 millisecond Off time
Excessive inductance change ($\pm 25\%$)	50 millisecond On time, 150 millisecond Off time

3.4 TABLE: SENSITIVITY, - $\Delta L/L$, AND RESPONSE TIMES

Sensitivity Level	Industry Reference	DIP Switch 6	DIP Switch 7	DIP Switch 8	- $\Delta L/L$ Threshold	Response Time (Fail-Secure Mode)	Response Time (Fail-Safe Mode)
0		OFF	OFF	OFF	1.28%	3.5 \pm 2.5 ms	65 \pm 25 ms
1		ON	OFF	OFF	0.64%	3.5 \pm 2.5 ms	65 \pm 25 ms
2	Low	OFF	ON	OFF	0.32%	3.5 \pm 2.5 ms	65 \pm 25 ms
3		ON	ON	OFF	0.16%	3.5 \pm 2.5 ms	65 \pm 25 ms
4	Normal	OFF	OFF	ON	0.08%	4.5 \pm 3.5 ms	65 \pm 25 ms
5		ON	OFF	ON	0.04%	7 \pm 6 ms	65 \pm 25 ms
6	High	OFF	ON	ON	0.02%	11.5 \pm 10.5 ms	65 \pm 25 ms
7		ON	ON	ON	0.01%	21.5 \pm 20.5 ms	65 \pm 25 ms

NOTE: To achieve the exact response times listed above, the Sensitivity level settings and Fail-Safe / Fail-Secure settings for both channels must be the same. To approximate the response time for a detector with the channels set to different sensitivities and/or Fail-Safe / Fail-Secure settings, look up the response time for each channel and divide it by two, then add these times together.

**3.5 TABLES: DEFAULT SETTINGS
FRONT PANEL MOUNTED DIP SWITCHES**

DIP Switch	Function	Setting	Position
1	Disable	Off	OFF
2	Frequency	0	OFF
3			OFF
4	Fail-Safe / Fail-Secure	Fail-Safe	ON
5	Presence / Pulse Mode	Presence	ON
6	Sensitivity	6	OFF
7			ON
8			ON

**3.6 TABLES: PIN ASSIGNMENTS
SOLID STATE OUTPUTS**

Pin	Function
A	DC Common
B	DC +
C	Reset Input
D	Channel 1 Loop Input
E	Channel 1 Loop Input
F	Channel 1 Output, Collector (Drain)
H	Channel 1 Output, Emitter (Source)
J	Channel 2 Loop Input
K	Channel 2 Loop Input
L	Chassis Ground
M	No Connection
N	No Connection
P	No Connection
R	No Connection
S	No Connection
T	No Connection
U	No Connection
V	No Connection
W	Channel 2 Output, Collector (Drain)
X	Channel 2 Output, Emitter (Source)
Y	No Connection
Z	No Connection

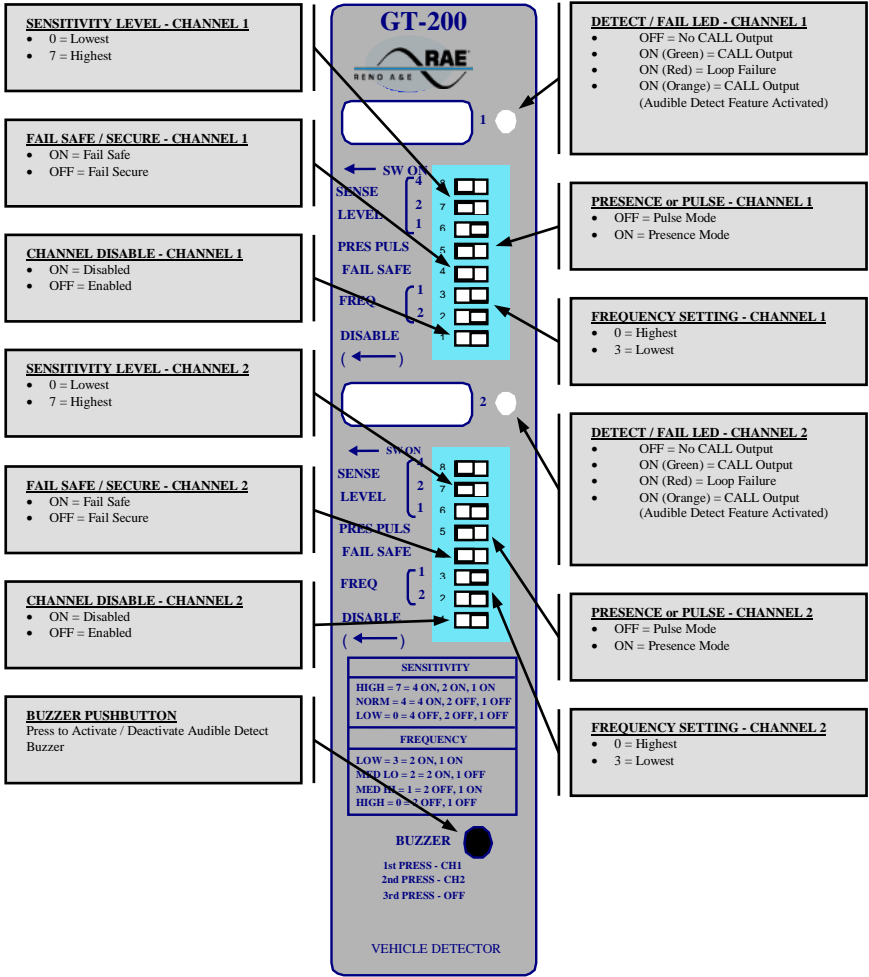
Pin	Function
1	Channel 1 Phase Green Input
2	Channel 2 Phase Green Input
3	No Connection
4	Channel 1 Loop Input
5	Channel 1 Loop Input
6	No Connection
7	Channel 1 TS 2 Status Output
8	Channel 2 Loop Input
9	Channel 2 Loop Input
10	No Connection
11	No Connection
12	No Connection
13	No Connection
14	No Connection
15	No Connection
16	No Connection
17	No Connection
18	No Connection
19	No Connection
20	Channel 2 TS 2 Status Output
21	No Connection
22	No Connection

RELAY OUTPUTS

Pin	Function
A	DC Common
B	DC +
C	Reset Input
D	Channel 1 Loop Input
E	Channel 1 Loop Input
F	Channel 1 Output, Relay Normally Open
H	Channel 1 Output, Relay Common
J	Channel 2 Loop Input
K	Channel 2 Loop Input
L	Chassis Ground
M	No Connection
N	No Connection
P	No Connection
R	No Connection
S	No Connection
T	No Connection
U	No Connection
V	No Connection
W	Channel 2 Output, Relay Normally Open
X	Channel 2 Output, Relay Common
Y	No Connection
Z	No Connection

Pin	Function
1	Channel 1 Phase Green Input
2	Channel 2 Phase Green Input
3	No Connection
4	Channel 1 Loop Input
5	Channel 1 Loop Input
6	No Connection
7	Channel 1 TS 2 Status Output
8	Channel 2 Loop Input
9	Channel 2 Loop Input
10	No Connection
11	No Connection
12	No Connection
13	No Connection
14	No Connection
15	No Connection
16	No Connection
17	No Connection
18	No Connection
19	No Connection
20	Channel 2 TS 2 Status Output
21	No Connection
22	No Connection

Section 4 User Interface



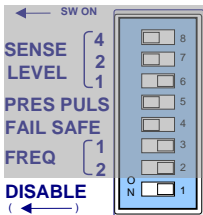
NOTE: There is a two-position DIP switch module located near the upper right corner of the PC board. DIP switch 1 must be in the OFF position for the detector to function properly.

Section 5 Installation and Set-Up

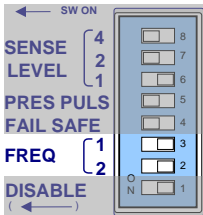
Each channel has a front panel mounted eight-position DIP switch module that is used to control the operation of the channel. The various switches can be set before or after the detector card is inserted into a card rack wired with appropriate contact assignments. The PRES PULSE, FAIL-SAFE, and DISABLE switches can be pre-selected for the desired operational state. The SENSE LEVEL and FREQ switches may require adjustment after the detector card has been inserted. When the detector is inserted, each channel will automatically tune to the loop circuit and begin operation within two seconds.

Ensure that DIP switch 1 on the two position DIP switch module located near the upper right corner of the PC board is set to the OFF position. This switch must be OFF for the detector to operate correctly. Plug the detector into an appropriately wired card rack receptacle and apply power.

5.1 FRONT PANEL PROGRAMMING DIP SWITCHES



Channel Disable: When DIP switch 1 is in the ON position, the channel will be disabled. Disabling a channel causes its output to remain in the NO CALL state. This switch is typically turned ON when a detector channel is not being used or has no loop connected to it. Disabling a channel will keep the Detect / Fail LED from displaying a loop fail indication when channels do not have loops connected to them. When a channel is disabled, its loop oscillator is disabled as well. Changing this setting will reset the channel. The factory default setting of this switch is OFF.



Frequency: The Model GT-200 detector sequentially activates each channel's loop circuit; so crosstalk between adjacent loops connected to different channels of the same detector is normally not a concern. Adjacent loops connected to different detectors may crosstalk. This may require changing the operating frequency of one of the loop circuits. If crosstalk is a problem, select another loop frequency for stable operation. Each channel of the Model GT-200 has four frequency selections that allow altering the resonant frequency of the loop circuit. The four frequency selections are controlled with two switches marked 2 and 3 on the DIP switch module. The values (1 and 2) to the left of the DIP switch are assigned to the switch when the switch is ON. If the switch is OFF, the switch has a value of zero (0). By adding the

switch *ON* and *OFF* values, the two switches can combine for values from 0 to 3 that indicate one of the four frequency selections. Use the following table as a reference for the selections and frequency settings. The factory default setting of these switches is switch 2 OFF and switch 3 OFF (HI).

NOTE: After changing the frequency switch setting, it is necessary to reset the channel by momentarily changing one of the other switch positions.

Frequency	Switch 2	Switch 3	Switch Values
HI*	OFF*	OFF*	0 + 0 = 0*
MED HI	ON	OFF	1 + 0 = 1
MED LO	OFF	ON	0 + 2 = 2
LO	ON	ON	1 + 2 = 3

* Factory default setting.

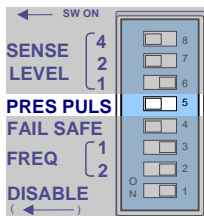


Fail-Safe / Fail-Secure: DIP switch 4 sets the default state of the channel's output when a loop failure condition exists on the loop network connected to the channel. One of two output states, shown in the table below, can be selected during a loop failure condition.

Operation	Detect / Fail LED	Output State
Fail-Safe	Solid ON (Red) -or- One Hz flash rate (Red)	CALL
Fail-Secure	Solid ON (Red) -or- One Hz flash rate (Red)	NO CALL

When the switch is in the ON position, the Fail-Safe Mode of operation is selected. Fail-Safe operation during a loop failure is the standard mode of operation for intersection control. When the switch is in the OFF position, the Fail-Secure mode of operation is selected. Fail-Secure operation during a loop failure is typically used in incident detection systems for freeway management. The factory default setting of this switch is ON (Fail-Safe Mode). Changing this setting will reset the channel.

NOTE: Selecting Fail-Secure also selects fast response (see Response Time in Section 3.3).

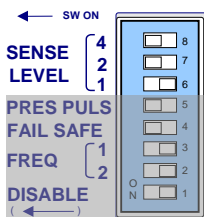


Output Mode: DIP switch 5 is used to select the desired output mode for each channel. One of two output modes can be selected:

PRESENCE (PRES): When the switch is in the ON position, Presence Mode is selected. When operating in Presence Mode, the detector will hold a small vehicle for a minimum of four minutes, and a small truck or a car for one to three hours. This is the factory default setting and the most common setting for most applications

PULSE (PULS): When the switch is in the OFF position, Pulse Mode is selected. When operating in Pulse Mode, the detector will generate a single 125 ms pulse output for each vehicle entering the loop detection area. Any vehicle remaining in the loop for over two seconds will be tuned out providing full sensitivity for the vacant portion of the loop detection zone. Full sensitivity for the entire loop detection zone is recovered within one second following the departure of any vehicle that has occupied the loop for longer than two seconds.

Changing this setting will reset the channel



Sensitivity: Each detector channel has eight sensitivity levels that are selected with three switches marked 6, 7, and 8 on the DIP switch module. The values (1, 2, and 4) to the left of the DIP switches are assigned to the switches when the switches are ON. If a switch is OFF, it has a value of zero (0). By adding the switch **ON** and **OFF** values, the three switches can combine for values from 0 to 7 indicating which of the eight sensitivity levels has been selected for the channel. Choose the lowest sensitivity level that will consistently detect the smallest vehicle that must be detected. Do not use a sensitivity level any higher than necessary. The factory default setting is sensitivity level 6 (- Δ L/L = 0.02%). The following table shows the actual sensitivity for each combination of switch settings. The factory default setting of these switches is switch 6 OFF, switch 7 ON, and switch 8 ON (sensitivity level 6, - Δ L/L = 0.02%). Changing the sensitivity level will reset the channel.

Sensitivity Level	Industry Reference	Switch 6	Switch 7	Switch 8	- Δ L/L Threshold
0		OFF	OFF	OFF	1.28%
1		ON	OFF	OFF	0.64%
2	Low	OFF	ON	OFF	0.32%
3		ON	ON	OFF	0.16%
4	Normal	OFF	OFF	ON	0.08%
5		ON	OFF	ON	0.04%
6*	High*	OFF*	ON*	ON*	0.02%*
7		ON	ON	ON	0.01%

* Factory default setting.

5.2 FRONT PANEL MOUNTED PUSHBUTTON - AUDIBLE DETECT SIGNAL (BUZZER)

The push button on the front panel labeled **BUZZER** is used to enable an Audible Detect Signal. When this feature is enabled (on), an audible signal will be activated whenever the detection zone for the selected channel is occupied. The audible signal indicates actual occupancy of the loop detection zone. Only one channel can be turned on at a time. Turning this feature on for one channel automatically turns it off for the other channels. To activate this feature, press the push button. The first time the push button is pressed, a short (50 millisecond) audible signal confirms the activation of the feature for Channel 1. The second time the push button is pressed, two short (50 millisecond) audible signals confirm the activation of the feature for Channel 2. To deactivate this feature, press and hold the push button for one second. A long (250 millisecond) audible signal confirms the deactivation of the feature. This feature is automatically disabled 15 minutes after activation or on loss of power.

NOTE: When operating in Pulse Mode, the audible detect signal will cease once a vehicle has occupied the detection zone for more than two seconds.

5.3 PC BOARD MOUNTED PROGRAMMING DIP SWITCHES

The Model GT-200 incorporates four PC board mounted, six-position DIP switch modules that are used to set Call Delay and Call Extension times.

Call Delay Control: Each detector channel can be independently set to provide a Delay Timing interval of 0 to 63 seconds in one-second increments. Call Delay settings are controlled via DIP switches 1, 2, 3, 4, 5, and 6 on DIP switch modules S1 and S4 located in the lower right quadrant of the PC board. The values (1, 2, 4, 8, 16, and 32) above or below the DIP switches are assigned to the switches when the switches are **ON**. If a switch is **OFF**, it has

a value of zero (0). By adding the switch *ON* and *OFF* values, the six switches can combine for values from 0 to 63 indicating the length of the Delay Timing interval that has been selected for the channel. The following table shows the actual Delay Time setting for each combination of switch settings. The factory default setting of all of these switches is *OFF* (no Delay Time programmed).

Delay Time Setting (Seconds)	Switch 1 (1)	Switch 2 (2)	Switch 3 (4)	Switch 4 (8)	Switch 5 (16)	Switch 6 (32)	Switch Values
0	OFF	OFF	OFF	OFF	OFF	OFF	0 + 0 + 0 + 0 + 0 = 0
1	ON	OFF	OFF	OFF	OFF	OFF	1 + 0 + 0 + 0 + 0 = 1
2	OFF	ON	OFF	OFF	OFF	OFF	0 + 2 + 0 + 0 + 0 = 2
3	ON	ON	OFF	OFF	OFF	OFF	1 + 2 + 0 + 0 + 0 = 3
4	OFF	OFF	ON	OFF	OFF	OFF	0 + 0 + 4 + 0 + 0 = 4
5	ON	OFF	ON	OFF	OFF	OFF	1 + 0 + 4 + 0 + 0 = 5
6	OFF	ON	ON	OFF	OFF	OFF	0 + 2 + 4 + 0 + 0 = 6
7	ON	ON	ON	OFF	OFF	OFF	1 + 2 + 4 + 0 + 0 = 7
8	OFF	OFF	OFF	ON	OFF	OFF	0 + 0 + 0 + 8 + 0 = 8
9	ON	OFF	OFF	ON	OFF	OFF	1 + 0 + 0 + 8 + 0 = 9
10	OFF	ON	OFF	ON	OFF	OFF	0 + 2 + 0 + 8 + 0 = 10
11	ON	ON	OFF	ON	OFF	OFF	1 + 2 + 0 + 8 + 0 = 11
12	OFF	OFF	ON	ON	OFF	OFF	0 + 0 + 4 + 8 + 0 = 12
13	ON	OFF	ON	ON	OFF	OFF	1 + 0 + 4 + 8 + 0 = 13
14	OFF	ON	ON	ON	OFF	OFF	0 + 2 + 4 + 8 + 0 = 14
15	ON	ON	ON	ON	OFF	OFF	1 + 2 + 4 + 8 + 0 = 15
16	OFF	OFF	OFF	OFF	ON	OFF	0 + 0 + 0 + 16 + 0 = 16
17	ON	OFF	OFF	OFF	ON	OFF	1 + 0 + 0 + 16 + 0 = 17
18	OFF	ON	OFF	OFF	ON	OFF	0 + 2 + 0 + 16 + 0 = 18
19	ON	ON	OFF	OFF	ON	OFF	1 + 2 + 0 + 16 + 0 = 19
20	OFF	OFF	ON	OFF	ON	OFF	0 + 0 + 4 + 16 + 0 = 20
21	ON	OFF	ON	OFF	ON	OFF	1 + 0 + 4 + 16 + 0 = 21
22	OFF	ON	ON	OFF	ON	OFF	0 + 2 + 4 + 16 + 0 = 22
23	ON	ON	ON	OFF	ON	OFF	1 + 2 + 4 + 16 + 0 = 23
24	OFF	OFF	OFF	ON	ON	OFF	0 + 0 + 0 + 8 + 16 + 0 = 24
25	ON	OFF	OFF	ON	ON	OFF	1 + 0 + 0 + 8 + 16 + 0 = 25
26	OFF	ON	OFF	ON	ON	OFF	0 + 2 + 0 + 8 + 16 + 0 = 26
27	ON	ON	OFF	ON	ON	OFF	1 + 2 + 0 + 8 + 16 + 0 = 27
28	OFF	OFF	ON	ON	ON	OFF	0 + 0 + 4 + 8 + 16 + 0 = 28
29	ON	OFF	ON	ON	ON	OFF	1 + 0 + 4 + 8 + 16 + 0 = 29
30	OFF	ON	ON	ON	ON	OFF	0 + 2 + 4 + 8 + 16 + 0 = 30
31	ON	ON	ON	ON	ON	OFF	1 + 2 + 4 + 8 + 16 + 0 = 31
32	OFF	OFF	OFF	OFF	OFF	ON	0 + 0 + 0 + 0 + 32 = 32
33	ON	OFF	OFF	OFF	OFF	ON	1 + 0 + 0 + 0 + 32 = 33
34	OFF	ON	OFF	OFF	OFF	ON	0 + 2 + 0 + 0 + 32 = 34
35	ON	ON	OFF	OFF	OFF	ON	1 + 2 + 0 + 0 + 32 = 35
36	OFF	OFF	ON	OFF	OFF	ON	0 + 0 + 4 + 0 + 32 = 36
37	ON	OFF	ON	OFF	OFF	ON	1 + 0 + 4 + 0 + 32 = 37
38	OFF	ON	ON	OFF	OFF	ON	0 + 2 + 4 + 0 + 32 = 38
39	ON	ON	ON	OFF	OFF	ON	1 + 2 + 4 + 0 + 32 = 39
40	OFF	OFF	OFF	ON	OFF	ON	0 + 0 + 0 + 8 + 32 = 40
41	ON	OFF	OFF	ON	OFF	ON	1 + 0 + 0 + 8 + 32 = 41
42	OFF	ON	OFF	ON	OFF	ON	0 + 2 + 0 + 8 + 32 = 42
43	ON	ON	OFF	ON	OFF	ON	1 + 2 + 0 + 8 + 32 = 43
44	OFF	OFF	ON	ON	OFF	ON	0 + 0 + 4 + 8 + 32 = 44
45	ON	OFF	ON	ON	OFF	ON	1 + 0 + 4 + 8 + 32 = 45
46	OFF	ON	ON	ON	OFF	ON	0 + 2 + 4 + 8 + 32 = 46
47	ON	ON	ON	ON	OFF	ON	1 + 2 + 4 + 8 + 32 = 47
48	OFF	OFF	OFF	OFF	ON	ON	0 + 0 + 0 + 16 + 32 = 48
49	ON	OFF	OFF	OFF	ON	ON	1 + 0 + 0 + 16 + 32 = 49
50	OFF	ON	OFF	OFF	ON	ON	0 + 2 + 0 + 16 + 32 = 50
51	ON	ON	OFF	OFF	ON	ON	1 + 2 + 0 + 16 + 32 = 51
52	OFF	OFF	ON	OFF	ON	ON	0 + 0 + 4 + 16 + 32 = 52
53	ON	OFF	ON	OFF	ON	ON	1 + 0 + 4 + 16 + 32 = 53
54	OFF	ON	ON	OFF	ON	ON	0 + 2 + 4 + 16 + 32 = 54
55	ON	ON	ON	OFF	ON	ON	1 + 2 + 4 + 16 + 32 = 55
56	OFF	OFF	OFF	ON	ON	ON	0 + 0 + 0 + 8 + 16 + 32 = 56
57	ON	OFF	OFF	ON	ON	ON	1 + 0 + 0 + 8 + 16 + 32 = 57
58	OFF	ON	OFF	ON	ON	ON	0 + 2 + 0 + 8 + 16 + 32 = 58
59	ON	ON	OFF	ON	ON	ON	1 + 2 + 0 + 8 + 16 + 32 = 59
60	OFF	OFF	ON	ON	ON	ON	0 + 0 + 4 + 8 + 16 + 32 = 60
61	ON	OFF	ON	ON	ON	ON	1 + 0 + 4 + 8 + 16 + 32 = 61
62	OFF	ON	ON	ON	ON	ON	0 + 2 + 4 + 8 + 16 + 32 = 62
63	ON	ON	ON	ON	ON	ON	1 + 2 + 4 + 8 + 16 + 32 = 63

Call Extension Control: Each detector channel can be independently set to provide an Extension Timing interval of 0 to 15.75 seconds in ¼-second increments. Call Extension settings are controlled via DIP switches 1, 2, 3, 4, 5, and 6 on DIP switch modules S2 and S5 located in the lower right quadrant of the PC board. The values (¼, ½, 1, 2, 4, and 8) above or below the DIP switches are assigned to the switches when the switches are *ON*. If a switch is *OFF*, it has a value of zero (0). By adding the switch *ON* and *OFF* values, the six switches can combine for values from 0 to 15.75 indicating the length of the Extension Timing interval that has been selected for the channel. The following table shows the actual Extension setting for each combination of switch settings. The factory default setting of all of these switches is *OFF* (no Extension Time programmed).

Extension Time Setting (Seconds)	Switch 1 (1/4)	Switch 2 (1/2)	Switch 3 (1)	Switch 4 (2)	Switch 5 (4)	Switch 6 (8)	Switch Values
0	OFF	OFF	OFF	OFF	OFF	OFF	0 + 0 + 0 + 0 + 0 = 0
0.25	ON	OFF	OFF	OFF	OFF	OFF	$\frac{1}{4} + 0 + 0 + 0 + 0 = 0.25$
0.50	OFF	ON	OFF	OFF	OFF	OFF	0 + $\frac{1}{2}$ + 0 + 0 + 0 = 0.50
0.75	ON	ON	OFF	OFF	OFF	OFF	$\frac{1}{4} + \frac{1}{2} + 0 + 0 + 0 = 0.75$
1.00	OFF	OFF	ON	OFF	OFF	OFF	0 + 0 + 1 + 0 + 0 = 1.00
1.25	ON	OFF	ON	OFF	OFF	OFF	$\frac{1}{4} + 0 + 1 + 0 + 0 = 1.25$
1.50	OFF	ON	ON	OFF	OFF	OFF	0 + $\frac{1}{2}$ + 1 + 0 + 0 = 1.50
1.75	ON	ON	ON	OFF	OFF	OFF	$\frac{1}{4} + \frac{1}{2} + 1 + 0 + 0 = 1.75$
2.00	OFF	OFF	OFF	ON	OFF	OFF	0 + 0 + 0 + 2 + 0 = 2.00
2.25	ON	OFF	OFF	ON	OFF	OFF	$\frac{1}{4} + 0 + 1 + 0 + 0 = 2.25$
2.50	OFF	ON	OFF	ON	OFF	OFF	0 + $\frac{1}{2}$ + 0 + 2 + 0 = 2.50
2.75	ON	ON	OFF	ON	OFF	OFF	$\frac{1}{4} + \frac{1}{2} + 0 + 2 + 0 = 2.75$
3.00	OFF	OFF	ON	ON	OFF	OFF	0 + 0 + 1 + 2 + 0 = 3.00
3.25	ON	OFF	ON	ON	OFF	OFF	$\frac{1}{4} + 0 + 1 + 2 + 0 = 3.25$
3.50	OFF	ON	ON	ON	OFF	OFF	0 + $\frac{1}{2}$ + 1 + 2 + 0 = 3.50
3.75	ON	ON	ON	ON	OFF	OFF	$\frac{1}{4} + \frac{1}{2} + 1 + 2 + 0 = 3.75$
4.00	OFF	OFF	OFF	OFF	ON	OFF	0 + 0 + 0 + 0 + 4 + 0 = 4.00
4.25	ON	OFF	OFF	OFF	ON	OFF	$\frac{1}{4} + 0 + 0 + 0 + 4 + 0 = 4.25$
4.50	OFF	ON	OFF	OFF	ON	OFF	0 + $\frac{1}{2}$ + 0 + 0 + 4 + 0 = 4.50
4.75	ON	ON	OFF	OFF	ON	OFF	$\frac{1}{4} + \frac{1}{2} + 0 + 0 + 4 + 0 = 4.75$
5.00	OFF	OFF	ON	OFF	ON	OFF	0 + 0 + 1 + 0 + 4 + 0 = 5.00
5.25	ON	OFF	ON	OFF	ON	OFF	$\frac{1}{4} + 0 + 1 + 0 + 4 + 0 = 5.25$
5.50	OFF	ON	ON	OFF	ON	OFF	0 + $\frac{1}{2}$ + 1 + 0 + 4 + 0 = 5.50
5.75	ON	ON	ON	OFF	ON	OFF	$\frac{1}{4} + \frac{1}{2} + 1 + 0 + 4 + 0 = 5.75$
6.00	OFF	OFF	OFF	ON	ON	OFF	0 + 0 + 0 + 2 + 4 + 0 = 6.00
6.25	ON	OFF	OFF	ON	ON	OFF	$\frac{1}{4} + 0 + 0 + 2 + 4 + 0 = 6.25$
6.50	OFF	ON	OFF	ON	ON	OFF	0 + $\frac{1}{2}$ + 0 + 2 + 4 + 0 = 6.50
6.75	ON	ON	OFF	ON	ON	OFF	$\frac{1}{4} + \frac{1}{2} + 0 + 2 + 4 + 0 = 6.75$
7.00	OFF	OFF	ON	ON	ON	OFF	0 + 0 + 1 + 2 + 4 + 0 = 7.00
7.25	ON	OFF	ON	ON	ON	OFF	$\frac{1}{4} + 0 + 1 + 2 + 4 + 0 = 7.25$
7.50	OFF	ON	ON	ON	ON	OFF	0 + $\frac{1}{2}$ + 1 + 2 + 4 + 0 = 7.50
7.75	ON	ON	ON	ON	ON	OFF	$\frac{1}{4} + \frac{1}{2} + 1 + 2 + 4 + 0 = 7.75$
8.00	OFF	OFF	OFF	OFF	OFF	ON	0 + 0 + 0 + 0 + 0 + 8 = 8.00
8.25	ON	OFF	OFF	OFF	OFF	ON	$\frac{1}{4} + 0 + 0 + 0 + 0 + 8 = 8.25$
8.50	OFF	ON	OFF	OFF	OFF	ON	0 + $\frac{1}{2}$ + 0 + 0 + 0 + 8 = 8.50
8.75	ON	ON	OFF	OFF	OFF	ON	$\frac{1}{4} + \frac{1}{2} + 0 + 0 + 0 + 8 = 8.75$
9.00	OFF	OFF	ON	OFF	OFF	ON	0 + 0 + 1 + 0 + 0 + 8 = 9.00
9.25	ON	OFF	ON	OFF	OFF	ON	$\frac{1}{4} + 0 + 1 + 0 + 0 + 8 = 9.25$
9.50	OFF	ON	ON	OFF	OFF	ON	0 + $\frac{1}{2}$ + 1 + 0 + 0 + 8 = 9.50
9.75	ON	ON	ON	OFF	OFF	ON	$\frac{1}{4} + \frac{1}{2} + 1 + 0 + 0 + 8 = 9.75$
10.00	OFF	OFF	OFF	ON	OFF	ON	0 + 0 + 0 + 2 + 0 + 8 = 10.00
10.25	ON	OFF	OFF	ON	OFF	ON	$\frac{1}{4} + 0 + 0 + 2 + 0 + 8 = 10.25$
10.50	OFF	ON	OFF	ON	OFF	ON	0 + $\frac{1}{2}$ + 0 + 2 + 0 + 8 = 10.50
10.75	ON	ON	OFF	ON	OFF	ON	$\frac{1}{4} + \frac{1}{2} + 0 + 2 + 0 + 8 = 10.75$
11.00	OFF	OFF	ON	ON	OFF	ON	0 + 0 + 1 + 2 + 0 + 8 = 11.00
11.25	ON	OFF	ON	ON	OFF	ON	$\frac{1}{4} + 0 + 1 + 2 + 0 + 8 = 11.25$
11.50	OFF	ON	ON	ON	OFF	ON	0 + $\frac{1}{2}$ + 1 + 2 + 0 + 8 = 11.50
11.75	ON	ON	ON	ON	OFF	ON	$\frac{1}{4} + \frac{1}{2} + 1 + 2 + 0 + 8 = 11.75$
12.00	OFF	OFF	OFF	OFF	ON	ON	0 + 0 + 0 + 0 + 4 + 8 = 12.00
12.25	ON	OFF	OFF	OFF	ON	ON	$\frac{1}{4} + 0 + 0 + 0 + 4 + 8 = 12.25$
12.50	OFF	ON	OFF	OFF	ON	ON	0 + $\frac{1}{2}$ + 0 + 0 + 4 + 8 = 12.50
12.75	ON	ON	OFF	OFF	ON	ON	$\frac{1}{4} + 0 + 1 + 0 + 4 + 8 = 12.75$
13.00	OFF	OFF	ON	OFF	ON	ON	0 + 0 + 1 + 0 + 4 + 8 = 13.00
13.25	ON	OFF	ON	OFF	ON	ON	$\frac{1}{4} + 0 + 1 + 0 + 4 + 8 = 13.25$
13.50	OFF	ON	ON	OFF	ON	ON	0 + $\frac{1}{2}$ + 1 + 0 + 4 + 8 = 13.50
13.75	ON	ON	ON	OFF	ON	ON	$\frac{1}{4} + \frac{1}{2} + 1 + 0 + 4 + 8 = 13.75$
14.00	OFF	OFF	OFF	ON	ON	ON	0 + 0 + 0 + 2 + 4 + 8 = 14.00
14.25	ON	OFF	OFF	ON	ON	ON	$\frac{1}{4} + 0 + 0 + 2 + 4 + 8 = 14.25$
14.50	OFF	ON	OFF	ON	ON	ON	0 + $\frac{1}{2}$ + 0 + 2 + 4 + 8 = 14.50
14.75	ON	ON	OFF	ON	ON	ON	$\frac{1}{4} + \frac{1}{2} + 0 + 2 + 4 + 8 = 14.75$
15.00	OFF	OFF	ON	ON	ON	ON	0 + 0 + 1 + 2 + 4 + 8 = 15.00
15.25	ON	OFF	ON	ON	ON	ON	$\frac{1}{4} + 0 + 1 + 2 + 4 + 8 = 15.25$
15.50	OFF	ON	ON	ON	ON	ON	0 + $\frac{1}{2}$ + 1 + 2 + 4 + 8 = 15.50
15.75	ON	ON	ON	ON	ON	ON	$\frac{1}{4} + \frac{1}{2} + 1 + 2 + 4 + 8 = 15.75$

5.4 PC BOARD MOUNTED DIP SWITCH - TEST MODE

Test Mode uses the microcontroller to verify the proper operation of the detector's controls and indicators (switches and LEDs). When connected to loops of the appropriate inductance (100 microhenries), each channel's

loop oscillator circuit can also be tested to verify the correct frequency range in each of the four frequency selections. Test Mode is selected by setting DIP switch 1 on the two position DIP switch module located near the upper right corner of the PC board to the ON position. Refer to Section 8.5 for a complete explanation of Test Mode operation.

5.5 PC BOARD MOUNTED DIP SWITCH - 100 MILLISECOND MINIMUM OUTPUT

This feature is used to ensure that CALLs output by the detector will be seen by the controller. Some controllers do not check the detector outputs often enough to catch very short detection events (<100 ms). This feature will cause all detection events less than 100 ms long to be 100 ms long.

When the detector is operating in Presence Mode, two modes of operation are available for the CALL outputs. Normal mode or 100 ms Minimum Output mode is selected via DIP switch 2 on the two-position DIP switch module located near the upper right corner of the PC board. When DIP switch 2 is in the **OFF** position, the CALL outputs stay on only as long as the detection zone is occupied. When DIP switch 2 is in the **ON** position, every CALL output will have a minimum duration of 100 ms.

5.6 LOOP FAIL INDICATIONS

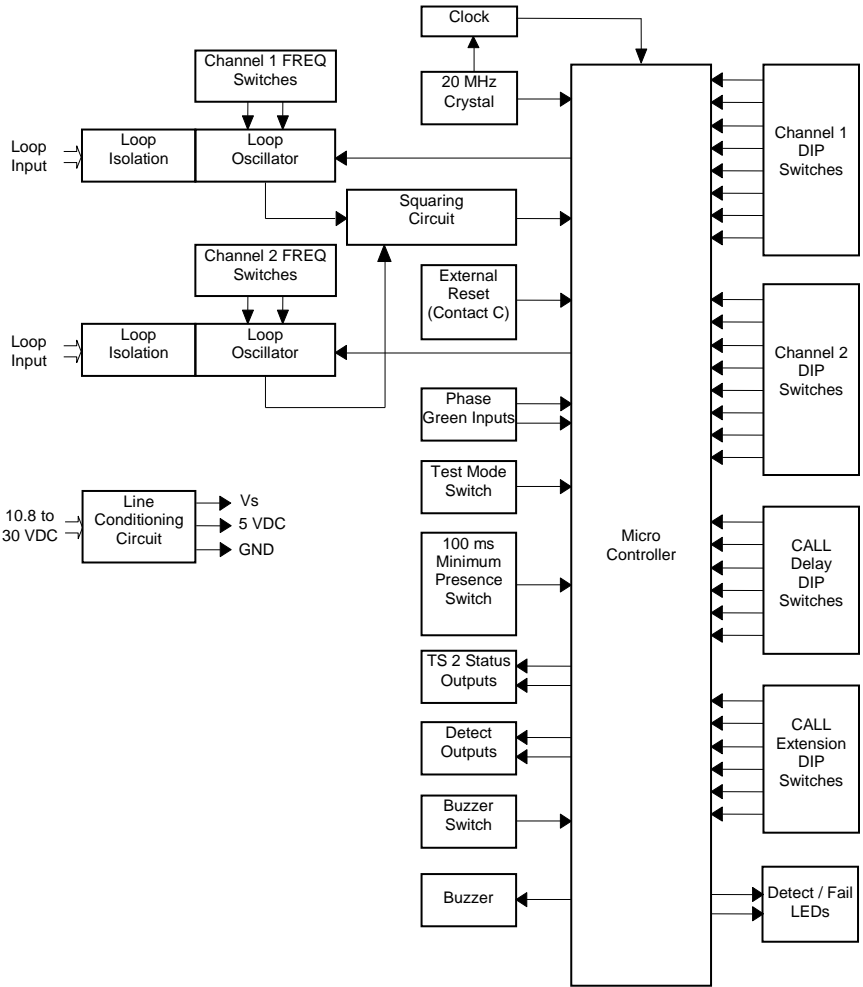
The Detect / Fail LED for each channel indicates loop failure problems according to the following table. The Detect / Fail LED is illuminated in a red state to provide an indication of either a current or prior out of tolerance (loop failure) condition. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% exists. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% exists. If the loop self heals, the channel will resume operation in a normal manner except that the Detect / Fail LED will begin to flash at a rate of three 50 millisecond (red) flashes per second, thus providing an alert that the channel has experienced a prior loop failure condition.

Detect / Fail LED	Meaning
OFF	No Loop Failure
Solid ON (Red)	Open Loop Failure or Inductance change condition of greater than +25% exists
One Hz flash rate (Red) (50% Duty Cycle)	Shorted Loop Failure or Inductance change condition of greater than -25% exists
Three 50 ms (Red) flashes per second	Loop Failure condition occurred but no longer exists

5.7 RESETTING THE DETECTOR

Changing the position of any of an individual channel’s front panel mounted DIP switches (except the Frequency switches) resets the channel. When the detector is installed and operating, the most convenient method for resetting is to momentarily change the position of the PRES PULS DIP switch and then return it to its original position. The detector can also be reset by connecting a logic ground signal to Contact C of the edge card connector or by the reapplication of power after a power loss.

Section 6 Block Diagram



Section 7 Theory of Operation

The Reno A & E Model GT-200 Detector digitally measures changes in the resonant frequency of two independent parallel tuned resonant circuits (loop / lead-in) to determine if a vehicle has entered the detection zones. The detector applies an excitation voltage to each loop circuit resulting in the loop oscillating at its resonant frequency. The current flow in the loop wire creates magnetic fields around the loop wire. When a vehicle passes over the loop area, the conductive metal of the vehicle causes a loading of the loop's magnetic fields. The loading decreases the loop inductance, which causes the resonant frequency to increase. By continuously sampling the loop's resonant frequency, the magnitude and rate of change can be determined. If the frequency change exceeds a selectable threshold (set by the sensitivity settings), the detector will activate an output signal. If the rate of change is slow, typical of environmental drift, the detector will continuously track and compensate for the change. The detector also monitors the loop frequency for out of range conditions such as an open or shorted loop circuit.

The detector scans the loop / lead-in circuit connected to each detector channel. The scanning method alternates the on and off cycle of each channel's loop circuit. Each channel's oscillator circuit supplies the excitation voltage that is coupled to the loop circuit by a loop isolation transformer. The transformer provides high common mode isolation between the loop and detector electronics, which allows the detector to operate on poor quality loops including a single short to ground. The transformer also limits the amount of static energy (lightning) that can transfer to the detector electronics. A spark gap transient suppression device is connected across the loop inputs to the isolation transformer. This device will dissipate static charges prior their reaching the transformer. The loop input is also filtered for 60-cycle noise. A network of three capacitors is connected to the detector side of the isolation transformer. The capacitors can be switched in or out of the oscillator circuit to shift the frequency of the loop circuit, thus providing frequency separation between adjacent loops.

The sine wave from the loop circuit is squared to allow the microcontroller to digitally measure the period of several cycles. A high-speed clock sets a reference count for the period in a counter. If the frequency increases, the period is shorter and the period count decreases. By comparing the new count with the reference count, a percentage of change can be calculated that indirectly relates to the inductance change. If the magnitude of the change exceeds a selectable threshold (sensitivity setting), the detector activates the output device.

The rate of change is also monitored. Slow rates of change typical of environmental drift are tracked and automatically compensated for. If the total inductance of the loop input network goes out of the range specified for the detector, or rapidly changes by more than $\pm 25\%$, the channel will immediately enter the programmed Fail-Safe or Fail-Secure mode of operation. Fail-Safe operation generates a continuous call output in the Presence Mode or Pulse Mode. Fail-Secure operation does not generate a call during the loop failure. In both modes of operation, the Detect / Fail LED will turn ON (red) or flash (red) at a one Hz rate and remain on or continue flashing for as long as the loop failure. If the loop self-heals, the channel will resume operation in a normal manner; except the Detect / Fail LED will begin to flash at a rate of three red flashes per second, thus providing an alert of a prior Loop Fail condition. The Detect / Fail LED will continue indicating the last loop failure condition until the detector is manually reset or power is removed.

The detector is designed to operate from D.C. power sources providing either 12 VDC or 24 VDC. On-board regulators provide regulated voltages so that either solid state or mechanical relay output versions can safely operate over the full input voltage range of 10.8 VDC to 30 VDC. The unit is also provided with an external reset capability. When Contact C of the edge card connector receives a logic ground signal for a minimum of 30 microseconds, both channels of the detector are immediately reset. Changing any front panel switch (except the frequency switches) resets the associated channel.

The operating parameters of each detector channel are established by DIP switch settings on DIP switch modules located on the front panel or PC board. Operating parameters that can be selected on the front panel are Sensitivity, Presence / Pulse Mode, Fail-Safe / Fail-Secure Operation, Loop Frequency, and Channel Disable. Operating parameters that can be selected on the PC board are 100 ms Minimum Presence Output, Test Mode, Delay Timing, and Extension Timing. A front panel mounted push button is used for activation of an audible detect signal. The loop frequency switches are directly connected to the tuning capacitors in the loop oscillator circuits. The settings of the remaining switches are strobed into the microprocessor. The microprocessor provides four output signals; a separate output line for each channel and a separate fail status line for each channel. Each output line drives either a fail-safe optically isolated transistor or a mechanical relay. Solid state output devices provide faster turn on and turn off times, thus giving more accurate information when the detector is used in speed and/or occupancy applications. The output signals are connected to two, dual color (green / red), front panel mounted Detect / Fail LEDs. Each LED corresponds to an individual detector channel. The Detect / Fail LEDs are normally extinguished when there are no detect outputs, the loops are in tolerance, and there have been no previous failure conditions. A Detect / Fail LED will be steady ON (green) when a current detect output state exists. A Detect / Fail LED will be steady ON (red) when a current open loop failure or an inductance change condition of more than 25% exists. A Detect / Fail LED will flash at a one Hz rate (red) when a current shorted loop failure or an inductance change condition of less than 25% exists. When a Detect / Fail LED flashes at a rate of three 50 millisecond flashes per second (red), it is an indication that the loop is currently in tolerance, but the detector channel has previously experienced an out of tolerance condition. If a current detect output state exists and a detector channel has previously experienced an out of tolerance condition, the corresponding Detect / Fail LED

will flash at a rate of three 50 millisecond flashes per second (red) followed by a single 750 millisecond flash (green). Either of these prior failure Detect / Fail LED flashing conditions will be reset whenever the detector is reset, the channel is reset, or power is interrupted.

The detector offers a choice of operation in either Fail-Safe or Fail-Secure Mode. Fail-Safe operation is the proper choice for intersection control applications where the detector should output a vehicle detect condition in the event of either a loop failure or power failure condition. Fail-Secure operation is the proper choice for freeway management applications where it is undesirable for the detector to output a vehicle detect condition for a loop failure condition. A vehicle detect condition on a freeway would be considered a stalled vehicle. When the detector is operated in the Fail-Secure Mode, the detector offers a faster response time than it does when operated in the Fail-Safe Mode. Slightly slower response times in the Fail-Safe Mode allow more filtering; hence, providing more noise immunity for intersection control applications.

The Reno A & E Model GT-200 detector is designed and manufactured using the latest available technology in electronic design and manufacturing; thus, providing the highest possible performance and reliability. Once properly installed, a Reno A & E loop detector will provide years of trouble free operation.

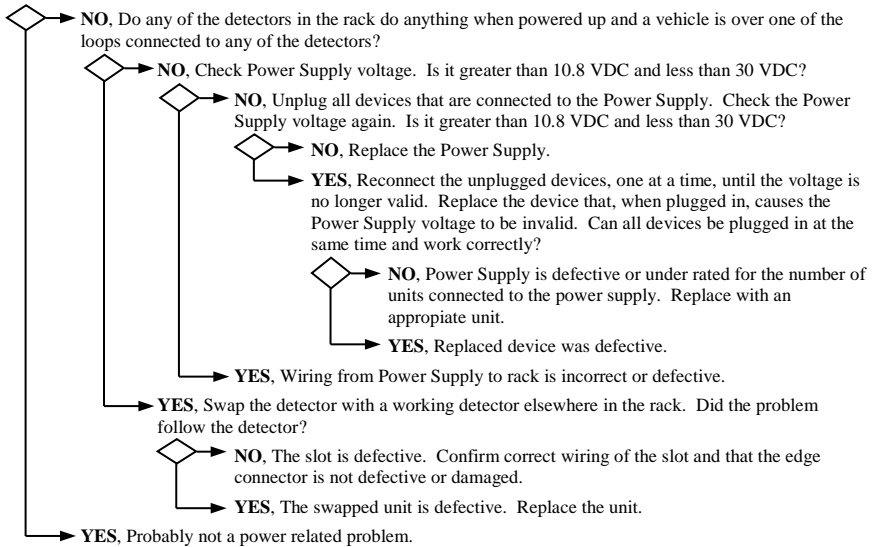
Section 8 Maintenance and Troubleshooting

The Reno A & E Model GT-200 Detector requires no maintenance. If you are having problems with your Model GT-200 detector, use the troubleshooting chart below to help determine the cause of the problem.

Symptom	Where To Start
No LEDs lit and detector does not respond to traffic.	See Troubleshooting Power Problems . Check for sensitivity set extremely low (0 to 2).
Both Channel Detect / Fail LEDs are ON (Green) and cannot be turned OFF, even when the channel is disabled.	Check the RESET line (Contact C), the detector is being continually reset.
LOOP FAIL indication (LED ON Red or flashing Red at a one Hz rate).	See Troubleshooting Loop Fail Problems .
Previous LOOP FAIL indication (LED flashing three times per second Red) and detector appears to be working correctly.	See Troubleshooting Intermittent Loop Fail Problems .
Detector intermittently stays in the Call state (LED ON Green).	See Troubleshooting Intermittent Detector Lock Ups .

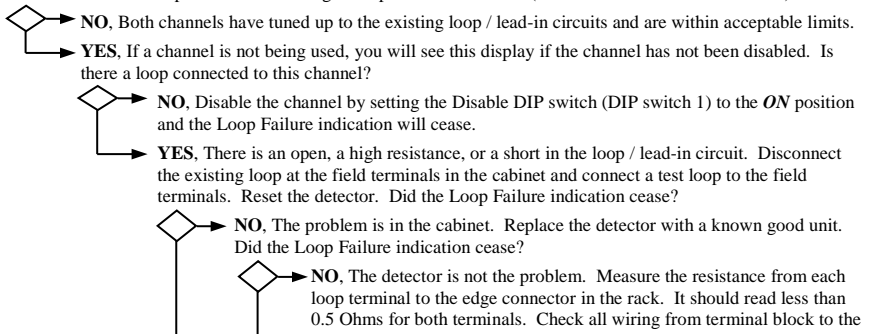
8.1 TROUBLESHOOTING POWER PROBLEMS

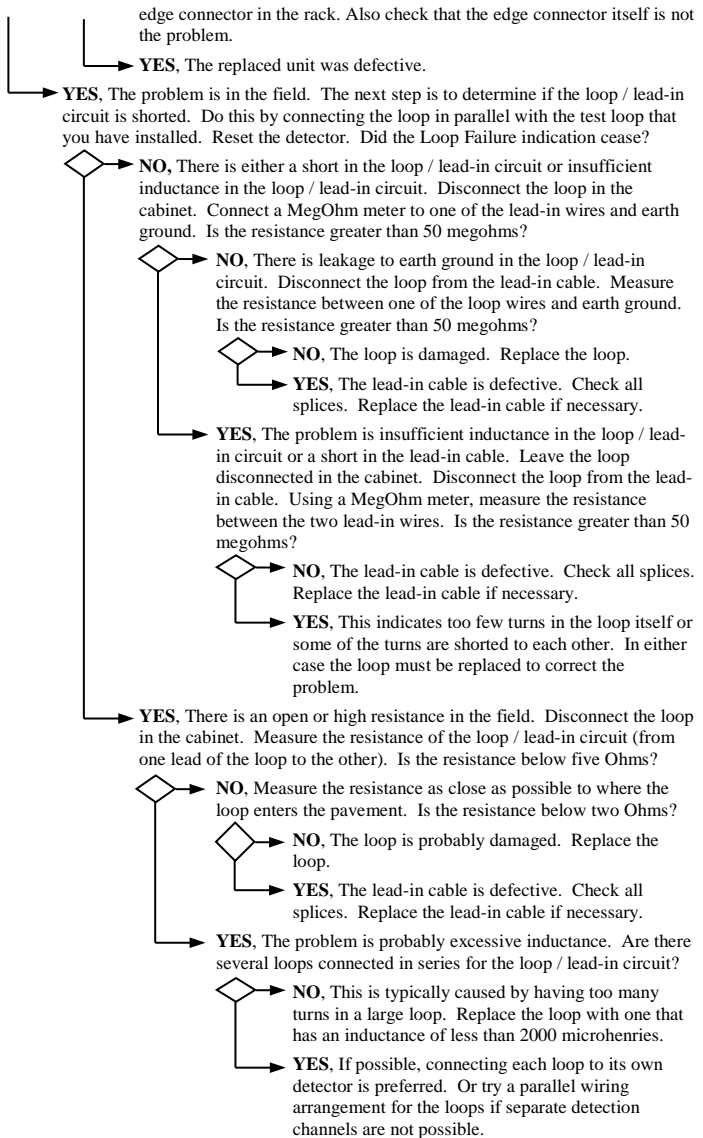
Do any of the LEDs turn ON (Green) when the detector is powered up and a vehicle is over one of the loops connected to the detector?



8.2 TROUBLESHOOTING LOOP FAIL PROBLEMS

Is one of the two front panel LEDs showing a Loop Failure indication (ON Red or one Hz flash rate Red)?





8.3 TROUBLESHOOTING INTERMITTENT LOOP FAIL PROBLEMS

Intermittent Loop Fail problems tend to be associated with bad splices in the loop / lead-in circuit, shorts in the loop / lead-in circuit, shorts to earth ground in the loop / lead-in circuit, or loose connections or bad solder joints in the signal cabinet. If you have any splices that are not soldered and sealed with an adhesive heat shrink or epoxy resin, replace the splice with one that is. Using a MegOhm meter, measure the resistance from one of the loop wires to earth ground. It should be greater than 50 megaohms. Inspect the loop. Look for exposed wires or debris pressed into the saw cut. Tighten all screw terminals in the signal cabinet that the loop circuit uses. Check solder joints in the loop circuit, especially on the rack itself. Disconnect and reconnect any connector used in the loop circuit and check for loose pins and sockets in these connectors. If your cabinet has lightning or surge suppression devices on the loop inputs in the cabinet, remove or replace them. Check for places in the field where the loop wire or lead-in cable may be pinched or chaffed. Look for wires pinched under junction box covers and where the wire enters conduit, especially where the loop wire leaves the saw cut and enters a conduit. After checking all of the above items, you could swap out the detector but this type of failure is rarely ever related to the detector.

8.4 TROUBLESHOOTING INTERMITTENT DETECTOR LOCK UPS

Problems of this type tend to be difficult to isolate due to the many possible causes and the short duration of the symptom (usually less than 30 minutes). If the problem occurs more frequently in the morning or when raining, suspect a short to earth ground in the loop / lead-in circuit. This can usually be verified by testing with a MegOhm meter but not always. Vibration can also be a possible cause. Loop wires may be moving slightly in a conduit due to vibrations from truck traffic. Utility lids in the street near the loop may also be a source of problems. Ensure that lids near a loop are bolted down so that they cannot move. Check that each set of loop wires is twisted together in any pull boxes and that lengths are not excessive. Inspect the loop. Look for exposed wires or debris pressed into the saw cut. Check for places in the field where the loop wire or lead-in cable may be pinched or chaffed. Look for wires pinched under junction box covers and where the wire enters a conduit, especially where the loop wire leaves the saw cut and enters a conduit. **If your cabinet has lightning or surge suppression devices on the loop inputs in the cabinet, remove or replace them.** If you have any splices that are not soldered and sealed with an adhesive heat shrink or epoxy resin, replace the splice with one that is. Solder all crimp connections in the loop circuit. Tighten all screw terminals in the signal cabinet that the loop circuit uses. Check solder joints in the loop circuit, especially on the harness itself. Disconnect and reconnect any connector used in the loop circuit and check for loose pins and sockets in these connectors.

8.5 TEST MODE OPERATION

Test Mode uses the microcontroller to verify the proper operation of the detector's controls and indicators (switches and LEDs). Each channel's loop oscillator circuit is also checked to verify the correct frequency in each of the four frequency selections. The frequency portion of the test requires the detector to be connected to a 100 microhenry loop. If an inductance value other than 100 microhenries is used, the frequency test results will be invalid.

NOTE: The test procedures outlined below should not be performed in an operational traffic signal cabinet.

Test Procedure (100 mSec Minimum Output DIP switch):

- STEP 1.** Remove power from the detector.
- STEP 2.** Set all front panel Channel 1 Programming DIP switches (SW1) to the **OFF** position.
- STEP 3.** Set all front panel Channel 2 Programming DIP switches (SW2) to the **OFF** position.
- STEP 4.** Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.
- STEP 5.** Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.
- STEP 6.** Set switch 1 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **ON** position.
- STEP 7.** Set switch 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.
- STEP 8.** Insert the detector into a suitable test fixture and apply power. All the LED indicators should be **OFF**. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.
- STEP 9.** Move switch 2 of the Test DIP switch module to the **ON** position. Move the switch to the **OFF** position after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
100mSEC MINIMUM OUTPUT TIME	2	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED

- STEP 10.** Remove power from the detector and set switch 1 of the Test DIP switch module to the **OFF** position.

Test Procedure (Programming DIP switches):

- STEP 1.** Remove power from the detector.
- STEP 2.** Set all front panel Channel 1 Programming DIP switches (SW1) to the **OFF** position.
- STEP 3.** Set all front panel Channel 2 Programming DIP switches (SW2) to the **OFF** position.
- STEP 4.** Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.
- STEP 5.** Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.
- STEP 6.** Set switch 1 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **ON** position.
- STEP 7.** Set switch 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.
- STEP 8.** Insert the detector into a suitable test fixture and apply power. All the LED indicators should be **OFF**. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.
- STEP 9.** Individually, turn ON switches 8, 7, 6, 5, 4, and 1 of the Channel 1 Programming DIP switch. Turn **OFF** each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
SENSE LEVEL 4	8	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
SENSE LEVEL 2	7	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
SENSE LEVEL 1	6	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
PRES PULS	5	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED

FAIL SAFE	4	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
DISABLE	1	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED

STEP 10. Individually, turn ON switches 8, 7, 6, 5, 4, and 1 of the Channel 2 Programming DIP switch. Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
SENSE LEVEL 4	8	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
SENSE LEVEL 2	7	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
SENSE LEVEL 1	6	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
PRES PULS	5	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
FAIL SAFE	4	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
DISABLE	1	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED

STEP 11. Remove power from the detector and set switch 1 of the Test DIP switch module to the **OFF** position.

Test Procedure (Frequency DIP switches):

- STEP 1.** Remove power from the detector.
STEP 2. Set all front panel Channel 1 Programming DIP switches (SW1) to the **OFF** position.
STEP 3. Set all front panel Channel 2 Programming DIP switches (SW2) to the **OFF** position.
STEP 4. Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.
STEP 5. Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.
STEP 6. Set switch 1 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **ON** position.
STEP 7. Set switch 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.
STEP 8. Insert the detector into a suitable test fixture and apply power. All the LED indicators should be OFF. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.
STEP 9. Individually, turn ON the two Channel 1 Frequency DIP switches (switches 3 and 2 of the Channel 1 Programming DIP switch). Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
FREQ 1	3	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
FREQ 2	2	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED

STEP 10. Individually, turn ON the two Channel 2 Frequency DIP switches (switches 3 and 2 of the Channel 2 Programming DIP switch). Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
FREQ 1	3	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
FREQ 2	2	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED

STEP 11. Remove power from the detector and set switch 1 of the Test DIP switch module to the **OFF** position.

An LED indication different than the ones described for each switch setting indicates the loop frequency is out of tolerance. Verify that the loop test coil has an inductance of 100 microhenries. If the test loop measures 100 microhenries the detector module should be serviced.

Test Procedure (Delay / Extension DIP switches):

- STEP 1.** Remove power from the detector.
STEP 2. Set all front panel Channel 1 Programming DIP switches (SW1) to the **OFF** position.
STEP 3. Set all front panel Channel 2 Programming DIP switches (SW2) to the **OFF** position.
STEP 4. Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.
STEP 5. Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.
STEP 6. Set switch 1 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **ON** position.
STEP 7. Set switch 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.
STEP 8. Insert the detector into a suitable test fixture and apply power. All the LED indicators should be OFF. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.
STEP 9. Individually, turn ON switches 1 through 6 of the Channel 1 Delay DIP switch. Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
DELAY 1	1	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
DELAY 2	2	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
DELAY 4	3	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED

DELAY 8	4	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
DELAY 16	5	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
DELAY 32	6	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN

STEP 10. Individually, turn ON switches 1 through 6 of the Channel 1 Extension DIP switch. Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
EXTEND 1/4	1	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 1/2	2	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
EXTEND 1	3	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 2	4	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN
EXTEND 4	5	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 8	6	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - GREEN

STEP 11. Individually, turn ON switches 1 through 6 of the Channel 2 Delay DIP switch. Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
DELAY 1	1	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
DELAY 2	2	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
DELAY 4	3	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
DELAY 8	4	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
DELAY 16	5	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
DELAY 32	6	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN

STEP 12. Individually, turn ON switches 1 through 6 of the Channel 2 Extension DIP switch. Turn OFF each switch after verifying the results indicated in the table below.

Switch Label	Switch #	LED Indications and Outputs
EXTEND 1/4	1	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 1/2	2	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
EXTEND 1	3	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 2	4	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN
EXTEND 4	5	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED
EXTEND 8	6	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - GREEN

STEP 11. Remove power from the detector and set switch 1 of the Test DIP switch module to the **OFF** position.

Test Procedure (Front Panel Buzzer switch):

STEP 1. Remove power from the detector.

STEP 2. Refer to the table in Section 3.5 and set all front panel Channel 1 and Channel 2 Programming DIP switches (SW1 and SW2) to their default positions.

STEP 3. Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.

STEP 4. Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.

STEP 5. Set switches 1 and 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.

STEP 6. Insert the detector into a suitable test fixture and apply power. All the LED indicators should be OFF. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.

STEP 7. Press the Front Panel mounted switch labeled **BUZZER**. The buzzer should sound once (50 ms).

STEP 8. Perform the actions and verify the results indicated in the table below.

Action	LED Indications and Outputs
INPUT CALL CHANNEL 1	CHANNEL 1 DETECT / FAIL LED ILLUMINATED - ORANGE BUZZER SOUNDS
REMOVE CALL CHANNEL 1	CHANNEL 1 DETECT / FAIL LED OFF BUZZER OFF

STEP 9. Press the Front Panel mounted switch labeled **BUZZER**. The buzzer should sound twice (50 ms).

STEP 10. Perform the actions and verify the results indicated in the table below.

Action	LED Indications and Outputs
INPUT CALL CHANNEL 2	CHANNEL 2 DETECT / FAIL LED ILLUMINATED - ORANGE BUZZER SOUNDS
REMOVE CALL CHANNEL 2	CHANNEL 2 DETECT / FAIL LED OFF BUZZER OFF

STEP 11. Press the Front Panel mounted switch labeled **BUZZER**. The buzzer should sound once (250 ms).

STEP 12. Remove power from the detector.

Test Procedure (Reset):

- STEP 1.** Remove power from the detector.
- STEP 2.** Refer to the table in Section 3.5 and set all front panel Channel 1 and Channel 2 Programming DIP switches (SW1 and SW2) to their default positions.
- STEP 3.** Set all PC board Channel 1 Delay / Extension DIP switches (S1 and S2) to the **OFF** position.
- STEP 4.** Set all PC board Channel 2 Delay / Extension DIP switches (S4 and S5) to the **OFF** position.
- STEP 5.** Set switches 1 and 2 of the Test DIP switch module (S3), located near the upper right corner of the PC board, to the **OFF** position.
- STEP 6.** Insert the detector into a suitable test fixture and apply power. All the LED indicators should be OFF. **NOTE: To test the frequency range, the channel must be connected to a 100 microhenry loop.** The other tests may be performed with any loops within the range of 20 to 2000 microhenries.
- STEP 6.** Perform the actions and verify the results indicated in the table below. NOTE: Unless otherwise noted, references to switches, buttons, or inputs in the table correspond to labels on test equipment supplied by Reno A & E.

Switch / Button / Input	Action	LED Indications and Outputs
CHANNEL 1 OPEN LOOP BUTTON	PRESS AND HOLD	DETECTOR CHANNEL 1 DETECT / FAIL LED ILLUMINATED - RED DETECTOR CHANNEL 1 OUTPUT ON TEST BOX CHANNEL 1 DETECT LED ON TEST BOX CHANNEL 1 TS 2 STATUS LED FLASH
CHANNEL 1 OPEN LOOP BUTTON	RELEASE	DETECTOR CHANNEL 1 DETECT / FAIL LED FLASH - RED (THREE 50 ms FLASHES PER SECOND) DETECTOR CHANNEL 1 OUTPUT OFF TEST BOX CHANNEL 1 DETECT LED OFF TEST BOX CHANNEL 1 TS 2 STATUS LED ON *
RESET BUTTON	PRESS & RELEASE	DETECTOR CHANNEL 1 DETECT / FAIL LED OFF TEST BOX CHANNEL 1 TS 2 STATUS LED ON
CHANNEL 2 OPEN LOOP BUTTON	PRESS AND HOLD	DETECTOR CHANNEL 2 DETECT / FAIL LED ILLUMINATED - RED DETECTOR CHANNEL 2 OUTPUT ON TEST BOX CHANNEL 2 DETECT LED ON TEST BOX CHANNEL 2 TS 2 STATUS LED FLASH
CHANNEL 2 OPEN LOOP BUTTON	RELEASE	DETECTOR CHANNEL 2 DETECT / FAIL LED FLASH - RED (THREE 50 ms FLASHES PER SECOND) DETECTOR CHANNEL 2 OUTPUT OFF TEST BOX CHANNEL 2 DETECT LED OFF TEST BOX CHANNEL 2 TS 2 STATUS LED ON *
RESET BUTTON	PRESS & RELEASE	DETECTOR CHANNEL 2 DETECT / FAIL LED OFF TEST BOX CHANNEL 2 TS 2 STATUS LED ON

* NOTE: The TS 2 Status LED may continue flashing for up to five seconds after the Open Loop button is released.

- STEP 12.** Remove power from the detector.

8.6 THINGS TO KNOW ABOUT LOOPS

Always use a wire with cross-linked Polyethylene insulation (insulation type XLPE) for loop wire.

Typical sensing height is 3/5 of the shortest leg of a loop. Therefore, a 6' x 6' loop will have a detection height of 4'.

The inductance of a conventional four-sided loop can be estimated using the formula:

$$L = P \times (T^2 + T) / 4$$

Where: L = Loop Inductance in microhenries
P = Loop Perimeter in feet
T = Number of Turns of Wire.

Therefore, a 6' by 6' loop with 3 turns would have an inductance of:

$$\begin{aligned}L &= (6 + 6 + 6 + 6) \times (3^2 + 3) / 4 \\L &= 24 \times (9 + 3) / 4 \\L &= 24 \times 12 / 4 \\L &= 24 \times 3 \\L &= 72 \text{ microhenries.}\end{aligned}$$

The inductance of a Quadrupole™ loop can be estimated using the formula:

$$L = [P \times (T^2 + T) / 4] + [CL \times (T^2 + T) / 4] \quad \text{Where: } \begin{array}{l} L = \text{Loop Inductance in microhenries} \\ P = \text{Loop Perimeter in feet} \\ T = \text{Number of Turns of Wire} \\ CL = \text{Length of Center Leg in feet.} \end{array}$$

Therefore, a 6' by 50' loop with a 2-4-2 configuration would have an inductance of:

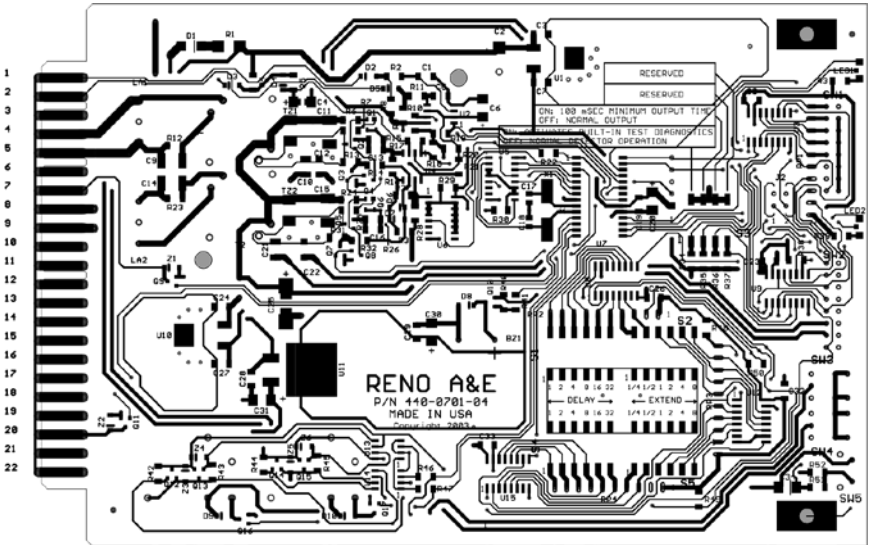
$$\begin{aligned}L &= [(6 + 50 + 6 + 50) \times (2^2 + 2) / 4] + [50 \times (4^2 + 4) / 4] \\L &= [112 \times (4 + 2) / 4] + [50 \times (16 + 4) / 4] \\L &= (112 \times 6 / 4) + (50 \times 20 / 4) \\L &= (112 \times 1.5) + (50 \times 5) \\L &= 168 + 250 \\L &= 418 \text{ microhenries.}\end{aligned}$$

Loop Feeder cable typically adds 0.22 microhenries of inductance per foot of cable.

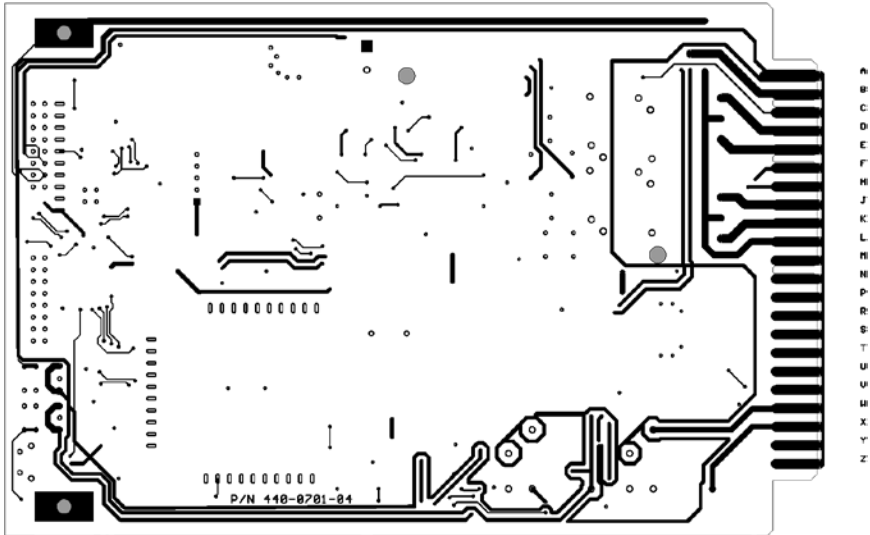
Total inductance of loops connected in series: $L_{\text{TOTAL}} = L_1 + L_2 + L_3 + \dots + L_N$.

Total inductance of loops connected in parallel: $L_{\text{TOTAL}} = 1 / [(1 / L_1) + (1 / L_2) + (1 / L_3) + \dots + (1 / L_N)]$.

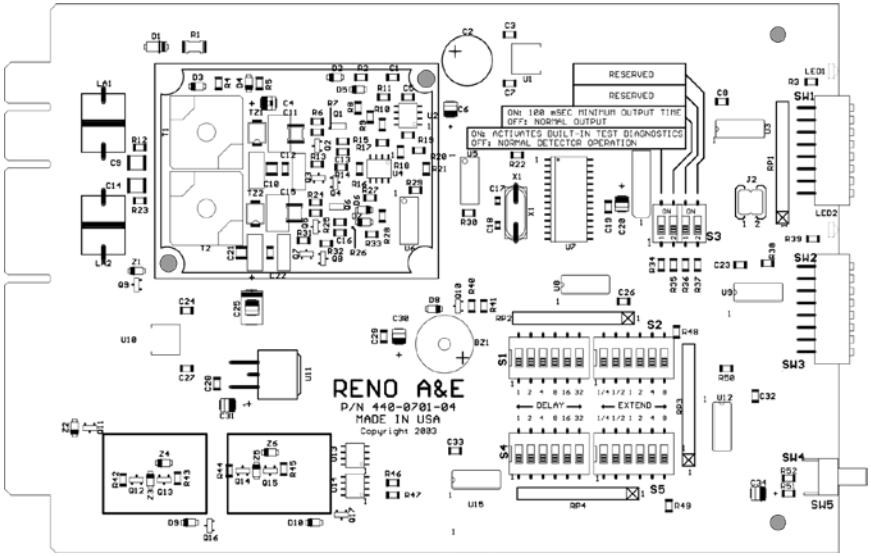
Section 10 PCB Layout



Top View



Bottom View



Parts Locator

Section 11 Parts List

SMT denotes a Surface Mount device; TH denotes a Through Hole device.

PART	QTY NUMBER	DESCRIPTION	SMT	TH	Model GT-200-R 400-0703-00	Model GT-200-SS 400-0702-05
PCB	440-0701-04	PRINTED CIRCUIT BOARD, GTS				X
BZ1	357-7006-00	TH BUZZER, MAGNETIC		X	X	X
C1	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C2	226-0477-00	TH CAPACITOR, ELECTROLYTIC, 470µF, 35V		X	X	X
C3	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C4	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C5	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C6	025-0105-00	SMT CAPACITOR, TANTALUM, 1µF, 35V, B PACKAGE	X		X	X
C7	020-0104-02	SMT CAPACITOR, X7R, 0.1µF, 0805, 50V	X		X	X
C8	025-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C9	020-0684-00	SMT CAPACITOR, X7R, 0.68µF, 1812, 50V	X		X	X
C10	021-0223-00 220-0223-00	SMT CAPACITOR, PPS, 0.022µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.022µF, 100V		X	X	X
C11	021-0683-00 220-0683-00	SMT CAPACITOR, PPS, 0.068µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.068µF, 100V		X	X	X
C12	021-0103-00 220-0103-00	SMT CAPACITOR, PPS, 0.01µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.01µF, 100V	X	X	X	X
C13	020-0683-00	SMT CAPACITOR, X7R, 0.068µF, 1206, 50V	X		X	X
C14	020-0684-00	SMT CAPACITOR, X7R, 0.68µF, 1812, 50V	X		X	X
C15	021-0103-00 220-0103-00	SMT CAPACITOR, PPS, 0.01µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.01µF, 100V	X	X	X	X
C16	020-0683-00	SMT CAPACITOR, X7R, 0.068µF, 1206, 50V	X		X	X
C17	022-0220-00	SMT CAPACITOR, NPO, 22pF, 0805	X		X	X
C18	022-0220-00	SMT CAPACITOR, NPO, 22pF, 0805	X		X	X
C19	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C20	025-0106-00	SMT CAPACITOR, TANTALUM, 10µF, 16V, B PACKAGE	X		X	X
C21	021-0223-00 220-0223-00	SMT CAPACITOR, PPS, 0.022µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.022µF, 100V	X	X	X	X
C22	021-0103-00 220-0103-00	SMT CAPACITOR, PPS, 0.01µF -OR- TH CAPACITOR, METALIZED POLYPROPYLENE, 0.01µF, 100V	X	X	X	X
C23	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C24	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C25	025-0106-00	SMT CAPACITOR, TANTALUM, 10µF, 16V, B PACKAGE	X		X	X
C26	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C27	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C28	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C29	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C30	025-0106-00	SMT CAPACITOR, TANTALUM, 10µF, 16V, B PACKAGE	X		X	X
C31	025-0106-00	SMT CAPACITOR, TANTALUM, 10µF, 16V, B PACKAGE	X		X	X
C32	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C33	020-0104-00	SMT CAPACITOR, X7R, 0.1µF, 1206, 50V	X		X	X
C34	025-0106-00	SMT CAPACITOR, TANTALUM, 10µF, 16V, B PACKAGE	X		X	X
D1	064-4004-00	SMT DIODE, POWER, RECTIFIER, SMA	X		X	X
D2	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D3	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D4	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D5	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D6	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D7	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D8	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D9	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
D10	060-1914-00	SMT DIODE, SMALL SIGNAL, SOD123	X		X	X
J1	372-0005-00	CONNECTOR, STRIP, 5 PIN, FEMALE, TEST PORT		X	X	X
LA1	349-0004-00	TH TRANSIENT PROTECTION, SPARK GAP, 3 PRONG		X	X	X
LA2	349-0004-00	TH TRANSIENT PROTECTION, SPARK GAP, 3 PRONG		X	X	X
LED1	141-0006-00	SMT LED, RIGHT ANGLE, RED, GREEN	X		X	X
LED2	141-0000-00	SMT LED, RIGHT ANGLE, RED, GREEN	X		X	X
Q1	044-0005-00	SMT TRANSISTOR, ARRAY, NPN, PAIR, COMMON BASE, BCV61B	X		X	X
Q2	040-3904-00	SMT TRANSISTOR, SMALL SIGNAL, NPN, SOT23	X		X	X
Q3	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q4	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q5	040-3904-00	SMT TRANSISTOR, SMALL SIGNAL, NPN, SOT23	X		X	X
Q6	044-0005-00	SMT TRANSISTOR, ARRAY, NPN, PAIR, COMMON BASE, BCV61B	X		X	X
Q7	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q8	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q9	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q10	040-3906-00	SMT TRANSISTOR, SMALL SIGNAL, PNP, SOT23	X		X	X
Q11	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q12	042-0001-00	SMT TRANSISTOR, DARLINGTON, NPN, SOT23, 2SD1383	X		X	X
Q13	043-0002-00	SMT TRANSISTOR, FET, P-CHANNEL, 60V, SOT23	X		X	X
Q14	042-0001-00	SMT TRANSISTOR, DARLINGTON, NPN, SOT23, 2SD1383	X		X	X
Q15	043-0002-00	SMT TRANSISTOR, FET, P-CHANNEL, 60V, SOT23	X		X	X
Q16	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
Q17	041-0002-00	SMT TRANSISTOR, DRIVER, NPN, SMT3, DCT114	X		X	X
R1	002-0100-00	SMT RESISTOR, 2010, 10 OHM	X		X	X
R2	001-0123-00	SMT RESISTOR, 1206, 12K OHM	X		X	X
R3	001-0511-00	SMT RESISTOR, 1206, 510 OHM	X		X	X
R4	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R5	001-0194-01	SMT RESISTOR, 1206, 191K OHM, 1%	X		X	X
R6	001-0302-00	SMT RESISTOR, 1206, 3K OHM	X		X	X
R7	001-0362-00	SMT RESISTOR, 1206, 3.6K OHM	X		X	X
R8	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R9	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R10	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R11	001-0123-00	SMT RESISTOR, 1206, 12K OHM	X		X	X
R12	001-0390-00	SMT RESISTOR, 1206, 39 OHM	X		X	X
R13	001-0242-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R14	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R15	001-0680-00	SMT RESISTOR, 1206, 68 OHM	X		X	X
R16	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R18	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R19	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R20	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R21	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X

PART	PART NUMBER	DESCRIPTION	SMT	TH	Model GT-200-R 400-0703-00	Model GT-200-SS-400-0702-05
R22	001-0102-00	SMT RESISTOR, 1206, 1K OHM	X		X	X
R23	001-0390-00	SMT RESISTOR, 1206, 39 OHM	X		X	X
R24	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R25	001-0362-00	SMT RESISTOR, 1206, 3.6K OHM	X		X	X
R26	001-0680-00	SMT RESISTOR, 1206, 68 OHM	X		X	X
R27	001-0394-00	SMT RESISTOR, 1206, 390K OHM	X		X	X
R28	001-0162-00	SMT RESISTOR, 1206, 1.6K OHM	X		X	X
R29	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R30	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R31	001-0242-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R32	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R33	001-0273-00	SMT RESISTOR, 1206, 27K OHM	X		X	X
R34	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R35	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R36	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R37	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R38	001-0123-00	SMT RESISTOR, 1206, 12K OHM	X		X	X
R39	001-0511-00	SMT RESISTOR, 1206, 510 OHM	X		X	X
R40	001-0243-00	SMT RESISTOR, 1206, 2.4K OHM	X		X	X
R41	001-0362-00	SMT RESISTOR, 1206, 3.6K OHM	X		X	X
R42	001-0563-00	SMT RESISTOR, 1206, 56K OHM	X		X	X
R43	001-0105-00	SMT RESISTOR, 1206, 1M OHM	X		X	X
R44	001-0563-00	SMT RESISTOR, 1206, 56K OHM	X		X	X
R45	001-0105-00	SMT RESISTOR, 1206, 1M OHM	X		X	X
R46	001-0162-00	SMT RESISTOR, 1206, 1.6K OHM	X		X	X
R47	001-0162-00	SMT RESISTOR, 1206, 1.6K OHM	X		X	X
R48	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R49	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R50	001-0103-00	SMT RESISTOR, 1206, 10K OHM	X		X	X
R51	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
R52	001-0472-00	SMT RESISTOR, 1206, 4.7K OHM	X		X	X
RL1	350-0012-00	TH RELAY, 12VDC, SENSITIVE, AZ8		X	X	
RL2	350-0012-00	TH RELAY, 12VDC, SENSITIVE, AZ8		X	X	
RP1	205-0103-00	TH RESISTOR, NETWORK, 10K OHM, SIP, 9 RESISTOR		X	X	X
RP2	205-0103-00	TH RESISTOR, NETWORK, 10K OHM, SIP, 9 RESISTOR		X	X	X
RP3	205-0103-00	TH RESISTOR, NETWORK, 10K OHM, SIP, 9 RESISTOR		X	X	X
RP4	205-0103-00	TH RESISTOR, NETWORK, 10K OHM, SIP, 9 RESISTOR		X	X	X
S1	121-0006-00	SMT SWITCH, DIP, 6 POSITION, FACE UP	X		X	X
S2	121-0006-00	SMT SWITCH, DIP, 6 POSITION, FACE UP	X		X	X
S3	121-0002-00	SMT SWITCH, DIP, 2 POSITION, FACE UP	X		X	X
S4	121-0006-00	SMT SWITCH, DIP, 6 POSITION, FACE UP	X		X	X
S5	121-0006-00	SMT SWITCH, DIP, 6 POSITION, FACE UP	X		X	X
SW1	321-0008-00	TH SWITCH, DIP, 8 POSITION, RIGHT ANGLE	X		X	X
SW2	321-0008-00	TH SWITCH, DIP, 8 POSITION, RIGHT ANGLE	X		X	X
SW3	322-0006-00	TH SWITCH, TOGGLE, RIGHT ANGLE, TINY, ON-OFF-MOMENTARY	X			
SW4	322-0006-00	TH SWITCH, TOGGLE, RIGHT ANGLE, TINY, ON-OFF-MOMENTARY	X			
SW5	322-0645-00	TH SWITCH, PUSH BUTTON, RIGHT ANGLE, BLACK, 6 x 6 MM	X		X	X
T1	348-1002-00	TH TRANSFORMER, ISOLATION, POTCORE, AL800	X		X	X
T2	348-1002-00	TH TRANSFORMER, ISOLATION, POTCORE, AL800	X		X	X
TZ1	068-0075-00	SMT DIODE, TRANZORB, 7.5V, SMB	X		X	X
TZ2	068-0075-00	SMT DIODE, TRANZORB, 7.5V, SMB	X		X	X
U1	094-0402-00	SMT LINEAR IC, LOGIC, VOLTAGE REGULATOR, 78M05	X		X	X
U2	094-0201-00	SMT LINEAR IC, COMPARETOR, LM393	X		X	X
U3	095-0000-00	SMT DIGITAL IC, LOGIC, 74HC165D, SOIC, 8 BIT	X		X	X
U4	094-0201-00	SMT LINEAR IC, COMPARETOR, LM393	X		X	X
U5	095-0700-00	SMT DIGITAL IC, LOGIC, 74HC112	X		X	X
U6	095-0700-00	SMT DIGITAL IC, LOGIC, 74HC112	X		X	X
U7	099-0004-00	SMT FLASH PROCESSOR, BLANK, SOIC28, PIC16F73-4SO	X		X	X
U8	095-0000-00	SMT DIGITAL IC, LOGIC, 74HC165D, SOIC, 8 BIT	X		X	X
U9	095-0000-00	SMT DIGITAL IC, LOGIC, 74HC165D, SOIC, 8 BIT	X		X	X
U10	094-0402-00	SMT LINEAR IC, LOGIC, VOLTAGE REGULATOR, 78M05	X		X	X
U11	094-0401-00	SMT LINEAR IC, LOGIC, VOLTAGE REGULATOR, 7805	X		X	X
U12	095-0000-00	SMT DIGITAL IC, LOGIC, 74HC165D, SOIC, 8 BIT	X		X	X
U13	094-0700-00	SMT LINEAR IC, LOGIC, OPTO COUPLER, MOC2D208	X		X	X
U14	094-0700-00	SMT LINEAR IC, LOGIC, OPTO COUPLER, MOC2D208	X		X	X
U15	095-0000-00	SMT DIGITAL IC, LOGIC, 74HC165D, SOIC, 8 BIT	X		X	X
X1	155-0206-00	SMT CRYSTAL, 20 MHz	X		X	X
	155-0206-00	TH CRYSTAL, 20 MHz		X	X	X
Z1	067-0330-00	SMT DIODE, ZENER, 33V, SOD123	X		X	X
Z2	067-0330-00	SMT DIODE, ZENER, 33V, SOD123	X		X	X
Z3	067-0330-00	SMT DIODE, ZENER, 33V, SOD123	X		X	X
Z4	067-0180-00	SMT DIODE, ZENER, 18V, SOD123	X		X	X
Z5	067-0330-00	SMT DIODE, ZENER, 33V, SOD123	X		X	X
Z6	067-0180-00	SMT DIODE, ZENER, 18V, SOD123	X		X	X

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