

Product: Sentinel Series Phones

The purpose of this application note is to describe the function of the batteries used in the Sentinel^(TM) Series phone and provide information that will assist in troubleshooting any problems that may arise.

If the NiCad battery is low or dead it is most likely that something is discharging or preventing the NiCad battery from charging. Also, keep in mind that extended shelf life can cause the NiCad Battery to discharge. If a low or dead NiCad battery condition exists, try to **find the problem**. If you just replace the battery or replace the chassis assembly, the problem will most likely reappear.

Battery Types

There are two batteries located on the Sentinel^(TM) Series chassis assembly: the NiCad battery and the Lithium battery.

NiCad Battery Function

The NiCad battery is a 4.8-volt rechargeable battery used to:

1. Retain the data programmed into the memory in the Sentinel^(TM) Series phone.
 2. Provide power to seize the central office loop for dial tone.
 3. Supply the energy required to operate the escrow relay.
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NiCad Battery Operation

The NiCad battery's charge is maintained by voltage that is supplied to the phone from 48-volt batteries located in the telephone company's Central Office (C.O.) This voltage maintains a current flow through the telephone company's tip and ring circuit (C.O. Loop Current) when the phone is off hook.

The NiCad battery draws energy from the C.O. loop only when the phone is off hook. This may occur during a normal call or during a battery charge routine. In either case, the charging current provided to the NiCad battery varies between 6 to 11 milli amps of current, depending upon the amount of C.O. loop current available to the phone ([See Reference Chart 1](#)).

NiCad Battery Charge Routine

NOTE: There are two levels of firmware released for the Sentinel Series products: Level 18 (DD7018-XX-XXX) and Level 19 (DD7019-XX-XXX). It is imperative to know which level firmware is installed in the phone before proceeding with the test.

WARNING! Do not rely on the label that is attached to the EPROM Chip. To correctly identify the firmware level, lift the handset, dial "* # 6 2" (followed by the 4-digit security code if applicable) and listen for the firmware description.

Battery Charge Routine - Level 18 Firmware

If the Sentinel_(TM) Series phone equipped with level 18 firmware determines that the NiCad battery charge is low, it automatically initiates a battery charge routine the next time the handset is lifted.

With level 18 firmware, the battery charge routine has priority. If a call is attempted during the battery charge routine, the user hears, "Please wait two minutes." This is followed by slow beeping tones.

Level 18 firmware requires approximately two minutes to complete the battery charge routine.

Battery Charge Routine - Level 19 Firmware

If the Sentinel_(TM) Series phone equipped with level 19 firmware determines that the NiCad battery charge is low, it automatically initiates a battery charge routine when the user hangs up.

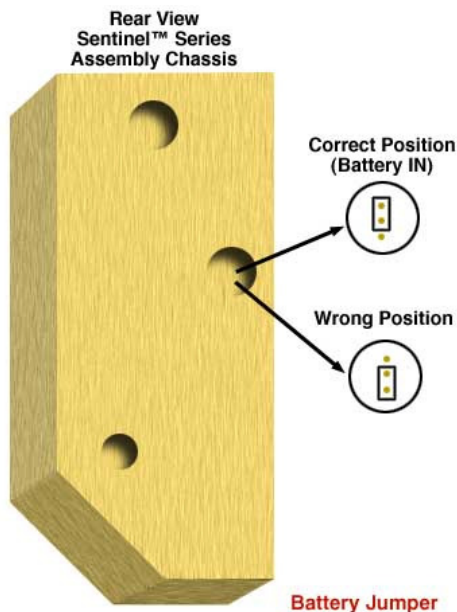
With level 19 firmware the user has priority. If a call is attempted during a battery charge routine, the phone will abort the routine and return dial tone to the user.

Level 19 firmware requires approximately seven minutes to complete the battery charge routine.

Lithium Battery Function

The lithium battery is a 3.6-volt non-rechargeable battery. It is the backup source of energy for two of the functions performed by the NiCad battery. The lithium battery ensures memory retention and the ability of the phone to seize the C.O. loop. The lithium battery is only used when the NiCad battery is disconnected or the NiCad battery's charge drops below 3.3 volts. The lithium battery is very important. If the phone seems dead, and replacing the NiCad battery fixes the problem, the lithium battery may be bad or not connected. Check for correct position of the [battery jumper \(see figure 1\)](#) on the back of the Sentinel[™] Series chassis assembly to ensure that the lithium battery is enabled.

Figure 1



Low Battery Flag

The Sentinel^(TM) Series phone reports a *Low Battery* flag to the computer after two consecutive attempts to perform the battery charge routine. It is possible for the NiCad battery to recover a full charge after one battery flag has been reported. However, if multiple *Low Battery* flags are reported to the computer or if there is no payphone activity, a technician should be dispatched to determine the cause of the low battery condition.

Troubleshooting Low Battery Symptoms

Possible Causes

- Excessive moisture/condensation on the chassis assembly or keypad/hookswitch assembly.

Note: Call Protel's Customer Service (941) 644-5558 for information about the new *rubber water seal* available for the upper housing (Part No. HDS0000157)

- Faulty electronic coin mechanism
 - Pinched battery wire in the upper housing
 - Faulty C.O. loop (tip and ring shorted or open)
 - Faulty charging circuit in the Sentinel^(TM) Series chassis assembly.
 - Faulty NiCad Battery
 - C.O. loop current too low
 - Low NiCad Battery voltage due to extended storage (shelf Life)
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Measuring the voltage charge in the NiCad Battery

NOTE: There are two levels of firmware released for the Sentinel_(TM) Series products: Level 18 (DD7018-XX-XXX) and Level 19 (DD7019-XX-XXX). It is imperative to know which level firmware is installed in the phone before proceeding with the test.

WARNING! Do not rely on the label that is attached to the EPROM Chip. To correctly identify the firmware level, lift the handset, dial "* # 6 2" (followed by the 4-digit security code if applicable) and listen for the firmware description.

Preparation with Level 18 Firmware

1. Lift the handset, deposit a coin in the phone and hang up the hand set. The phone should return the coin.
2. Repeat this routine three times. This will deplete energy from the NiCad battery and reduce the battery's performance if the battery is weak or damaged.

NOTE: If the phone goes into the battery charge routine after returning the coin, allow the battery charge routine to complete before proceeding with the test ([See NiCad Battery Charge Routine](#)).

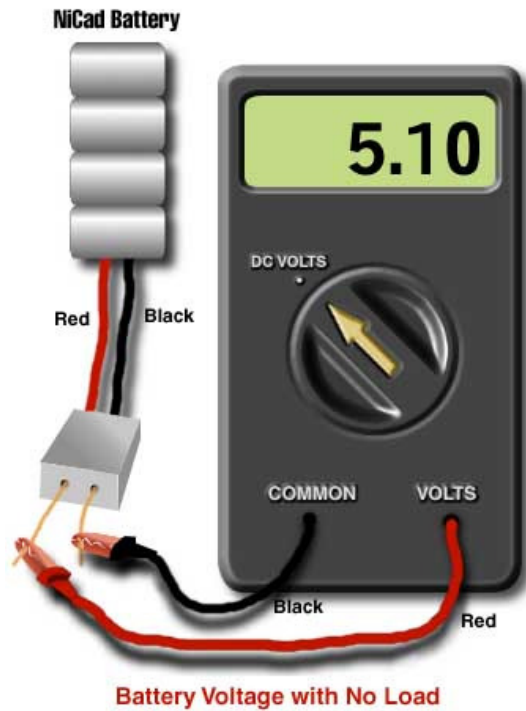
Preparation with Level 19 Firmware

1. Lift the handset, deposit a coin in the phone then hang up. The phone should return the coin.
2. Lift the handset, dial "* # 6 7" (and the security code if applicable) and listen for beep/beeps. One beep = battery charge good
Two beeps = battery charge marginal
Three beeps = battery charge low
3. If two or three beeps are heard, force a battery charge routine by lifting the handset and dialing "* # 6 8" (and the security code if applicable). Listen for "Wait one moment" before hanging up the handset.
4. The battery charge routine requires approximately seven minutes to complete.

Measuring the NiCad Battery Voltage

1. Disconnect the NiCad battery from the chassis assembly.
 2. Connect a volt meter to the battery connector and measure the battery voltage ([See figure 2](#))
 - a. If the battery voltage measures 5 volts or greater, the battery is probably good but may be weak. Measure for correct loop current ([See Testing The C.O. Loop Current](#)). Also, test the charging circuits ([See Testing The Charging Circuits](#)).
 - b. If the battery measures 3.9 to 4.2 volts immediately after a battery charge routine, one of the four battery cells is probably shorted.
 - c. With level 18 firmware, complete a one-minute phone call so the battery charges. With level 19 firmware, force a battery charge routine by dialing "*#68" (and the security code if applicable).
 - d. Repeat steps 1 and 2. If the reading is still 4.2 or lower, replace the battery.
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Figure 2



Testing The C.O. Loop Current

1. Connect a current meter in series with either tip or ring ([See Figure 3](#)).
2. Lift the handset off hook and record the current reading indicated on the meter.
The current reading must be 21mA or greater.
3. Record the loop current reading.

Checking The Battery For Discharge While On Hook

1. Use a known good NiCad battery as your test battery. Cut the black wire for connection to the current meter as shown in [figure 4](#).
2. Hang up the phone and wait approximately 5 seconds. Then, read the meter.

3. If any discharge current greater than 30 micro amps (.030 mA) is detected, disconnect, one at a time, each of the components listed in the section titled "**Checking for Faulty Components.**"
4. Replace any components, that when disconnected, cause the battery current to decrease.
5. If the battery continues to discharge after testing each component, replace the chassis assembly.



Figure 3



Off-Hook Loop Current After Completing Call

Testing The Charging Circuits

1. Verify the loop current is greater than 21ma. See [Testing the C.O. Loop Current](#).
2. Use a known good NiCad battery as your test battery. Cut the black wire for connection to the current meter as shown.



Figure 5

3. Lift the handset off hook and compare the charge current reading with the C.O. loop current using the reference chart below.

Charging Circuit Reference Chart 1	
C.O. Loop Current	Battery Charge Current
21mA	+6mA
22mA	+7mA
23mA	+8mA
24mA	+9mA
25mA or greater	+10mA to +11mA

- a. If the *battery charge current* reading is approximately the same as that listed in the chart for the given C.O. loop current, the battery is charging okay.

Note: If the meter pointer is reading backwards (analog meter) or the digital reading is negative, reference [Figure 5](#) to verify that the meter leads are connected properly.

- b. If the *battery charge current* reading is good, proceed to the section titled "**Checking the battery for discharge while on hook**".
 - c. If the *battery charge current* reading is low, proceed to the section titled "**Checking for Faulty Components**".
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Checking For Faulty Components

1. Perform this check only if the procedure titled "Testing the Charging Circuits" fails.
 2. Verify the loop current is greater than 21ma. See [Testing the C.O. Loop Current](#).
 3. Use a known good NiCad battery as your test battery. Cut the black wire for connection to the current meter as shown in [figure 5](#).
 4. Make sure that the phone is off hook (fresh dial tone).
 5. Watch the milli amp meter and disconnect, one at a time, each of the components listed below. Replace any component, that when disconnected, causes the charging current to increase.
 - Electronic Coin Mechanism
 - Coin Box Switch
 - Handset
 - Loud Button
 - Substitute a new keypad assembly
 6. If the charging current is still low, replace the chassis assembly.
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Charging The Battery Using An External Charger

The NiCad battery in the Sentinel_(TM) Series phone has the capacity of 110 Milli Amp hours. This means that a fully charged battery will supply 110 Milli Amps of current for 1 hour or 55 Milli Amps for 2 hours, etc. When charging the battery, ensure that the recommended charging rate is not exceeded.

There are two charging rates recommended by the battery manufacturer:

Slow Charge 11mA for 15 hours.

Fast Charge 33mA for 7 hours.

NOTE 1

If the NiCad battery is dead it is most likely that something is discharging or preventing the NiCad battery from charging. Find the problem; if you just replace the battery or the chassis assembly, the problem will probably reappear.

NOTE 2

Extended shelf life can cause the NiCad battery to discharge. If problems are experienced after installation, perform the tests listed above to isolate and resolve the problem.