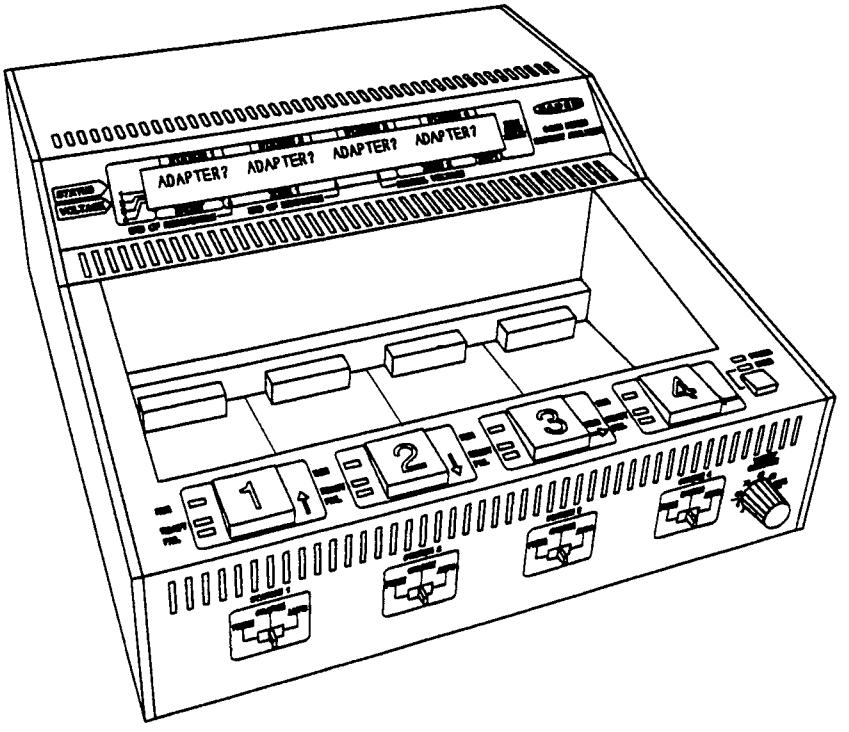
CADEX C4000 SERIES
BATTERY ANALYZER



USER'S MANUAL

CADEX ELECTRONICS INC.
111- 7400 MacPherson Ave.
Burnaby, B.C. Canada V5J 5B6

Tel (604) 451-7900
Fax (604) 451-7991
Toll Free 1-800-565-5228

WARRANTY

CADEX ELECTRONICS INC. warrants the Cadex C4000 Battery Analyzer against defective materials and workmanship for ONE YEAR from the purchase date. Service is available by returning the unit to the manufacturer. The manufacturer will assume one half of the shipping cost.

DISCLAIMER

The information contained herein is accurate to the best of our knowledge and belief. Since the conditions of handling and use are beyond our control, we make no guarantee on results if equipment is improperly handled or misused.

REVISIONS

CADEX ELECTRONICS INC. reserves the right to revise this publication and make changes in the contents hereof without obligation to notify any person of such changes.

TRADEMARK

CADEX is a registered trademark of CADEX ELECTRONICS INC.

COPYRIGHT

Copyright (c) 1993 by **CADEX ELECTRONICS INC.** All rights are reserved. No part of this publication or the firmware controlling the CADEX product(s) may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise without the written permission of CADEX ELECTRONICS INC. 111- 7400 MacPherson Ave. Burnaby, B.C., Canada V5A 3G1.

Document MUC49503
Firmware Versions V3.00 &V3.00P

DO'S AND DONT'S

Do:

- **Connect the C4000 Battery Analyzer to the correct line voltage.** The operating voltage is indicated on the instrument label on bottom of the unit.

- **Recharge NiCd batteries between 5°C and 35 °C (41°F and 96 °F).** Fast-charging outside this temperature range may cause damage to the battery.

Note Allow cold battery to warm up before charging;
Allow hot battery to cool before charging.

- **Use the correct battery for which the adapter is configured to.** Failure to do so may cause damage to the battery. Battery parameters can be verified by pressing the appropriate Display Key when the Station is empty.

- **Clean battery contacts before servicing.**

Don't:

- **Do not short leads from one Station to another or to the case.** An electrical short to any point outside the Station bypasses the current regulation loop and will cause a fuse to blow. A shorted battery will cause no harm.

- **Do not transmit in close proximity.** The C4000 is equipped with high frequency switch-mode power supplies. The advanced circuits may be sensitive to RF interference.

- **Rule of Thumb:** The following distances should be observed when transmitting:

0.5 Watt of transmit power = 0.3m (1')
1 Watt of transmit power = 0.6m (2')
2 Watts of transmit power = 1.2m (4')
4 Watts of transmit power = 2.4m (8')

- **Do not restrict the airflow of the analyzer.** Leave the fan opening clear. Fan operation is automatic.

- **Do not expose LCD to direct sunlight.**

WARRANTY I
DO'S AND DON'TS II

CHAPTER 1 - INTRODUCTION **1-1**

1. Overview of Cadex C4000 1-2
2. Getting Started 1-3

CHAPTER 2 - BASIC OPERATION **2-1**

1. Power Up 2-2
2. Analyzing Batteries 2-3
3. Evaluation of Battery Results 2-6

CHAPTER 3 - PROGRAMS & TARGET CAPACITY **3-1**

1. Application Table 3-2
2. Prime 3-3
3. Charge 3-5
4. Auto 3-6
5. Custom 3-8
6. Standby 3-8
7. Target Selector 3-9
8. Calculation of Target Capacity 3-10

CHAPTER 4 - STATUS INDICATORS **4-1**

1. LED Indicators 4-2
2. Audible Tone Signals 4-3
3. Status Indicator Tables 4-4
4. Display (LCD) 4-6
5. Display Messages 4-8

CHAPTER 5 - FAULT CODES **5-1**

1. Application Tables 5-2
2. Correctable Faults 5-4
3. Voltage Faults 5-6
4. Timing Faults 5-9
5. Temperature Criteria 5-10
6. Electrical Limitations 5-11
7. Corrected Faults 5-12

CHAPTER 6 - BATTERY ADAPTERS **6-1**

1. Battery Adapter Styles 6-2
2. Installation 6-4
3. Battery Adapter Errors 6-5

CHAPTER 7 - PROGRAMMING BATTERY ADAPTERS **7-1**

1. C-Code Definition 7-2
2. C-Code Structure 7-3
3. Quick View of Battery Parameters 7-4
4. Menu Tree 7-4
5. Menu Functions 7-6

CHAPTER 8 - UTILITIES **8-1**

1. Reset to Factory Default 8-2
2. Copy Settings 8-3
3. Set Password 8-3
4. Station Target Capacity 8-5
5. Company Name 8-5
6. Calibrate Station 8-6

CHAPTER 9 - CUSTOM PROGRAMS **9-1**

1. Setting up Custom Program 9-2
2. Typical Applications 9-5
3. Code Definition 9-8
4. Program Variations 9-11

CHAPTER 10 - OPTIONS **10-1**

1. Data Retention 10-2
2. Date/Time 10-3
3. Printer Interface 10-4
4. Print Formats 10-5
5. Computer Interface 10-7
6. Event Log 10-8

CHAPTER 11 - C-CODE TABLES **11-1**

1. Battery Type 11-7
2. Number of Cells 11-8
3. Battery Rating 11-9
4. C-Rate 11-11
5. Trickle Charge 11-13
6. Recondition Discharge 11-14
7. Capacity Offset 11-15
8. Temperature Sensor 11-17
9. Negative Slope 11-17
10. End of Discharge 11-18
11. End of Recondition (NiCd, NiMH) 11-19
12. charge method 11-19
13. Float Voltage (SLA) 11-20
14. Voltage Limit (SLA) 11-21
15. Topping Charge Plateau (SLA) 11-22

CHAPTER 12 - DIAGNOSTICS 12-1

1. RAM/Clock/LCD Check 12-2
2. Start-up Messages 12-3

CHAPTER 13 - SERVICE 13-1

1. Static Precautions 13-2
2. Replacing Fuses 13-2
3. Replacing Back-up Battery 13-3
4. Replacing the EPROM 13-5
5. Installing OPTION-P 13-6
6. Motherboard Layout 13-8

CHAPTER 14 - SPECIFICATIONS 14-1

APPENDIX A-1

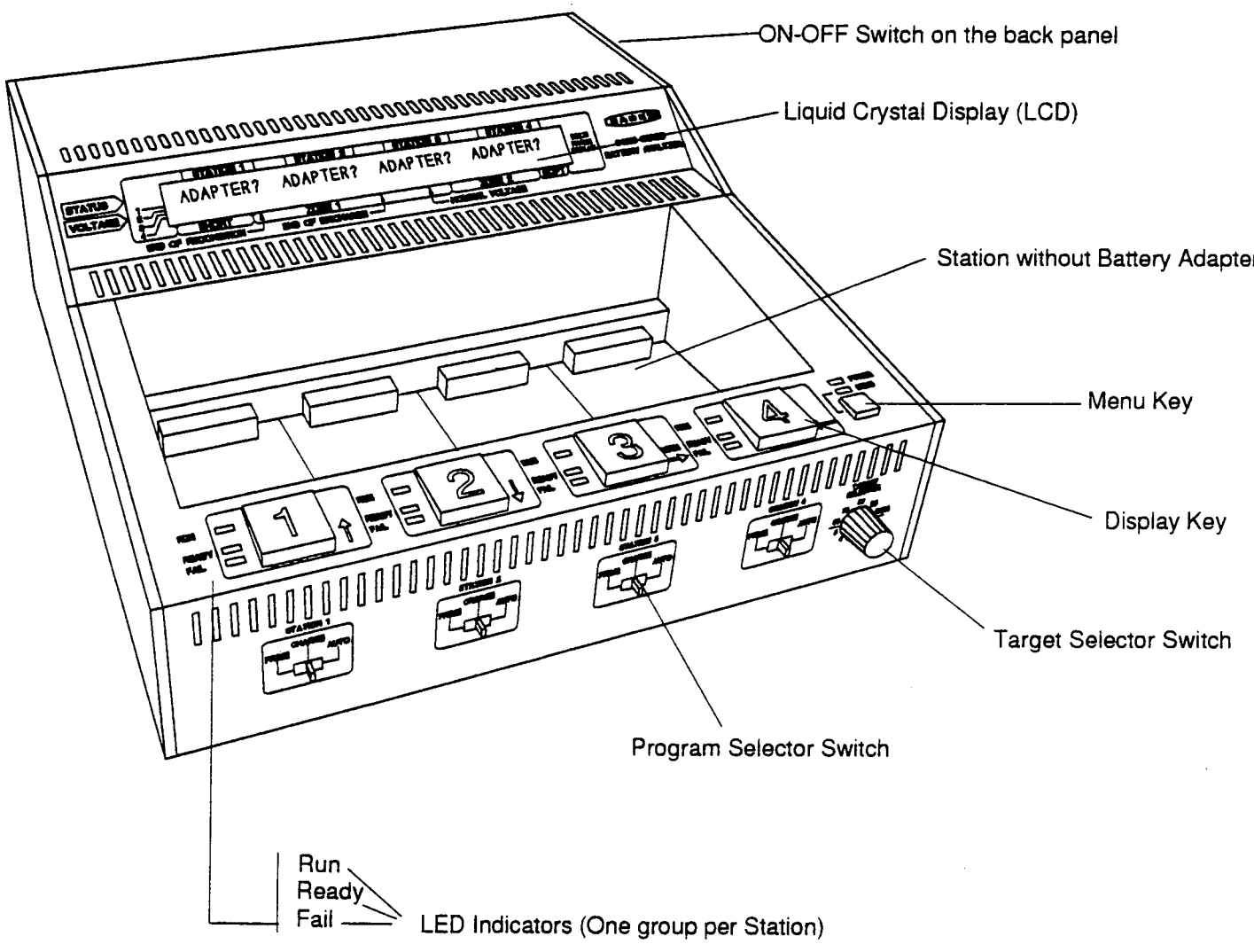
GLOSSARY G-1

INDEX I-1

CHAPTER 1

INTRODUCTION

1. Overview of Cadex C4000



2. Getting Started

Plug in and turn on

Plug and on-off switch are located on the back of the C4000.

Select the program

The Program Selector Switch is on the front of the analyzer.

Select:
- PRIME for new or stored batteries prior to use
- CHARGE for fast-charging only (no analysis)
- AUTO to service batteries with unknown conditions.

Set Target Selector

Target Selector switch is on the right hand side of the front panel.

Select:
- **80%** for most requirements
- **90%** or **100%** for more demanding applications
- **60%** or **70%** for less critical applications.

Battery Adapter

Configured Battery Adapters are pre-programmed for specific battery types. To reprogram, refer to CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS.

Insert the Battery

When contact is made, a "Beep" is heard and the yellow RUN LED comes on.

When battery servicing is complete

The Green READY LED is on if the battery has successfully completed the program.

The red FAIL LED comes on if the battery has failed to meet the specified requirement.

Display

Global The status of each battery is shown on the top line of the LCD display. The lower section of the LCD shows the relative voltage of each battery in a line-graph form.

Detailed Detailed information about the battery can be seen by pressing the corresponding Display Key.

After completion of the program

Record the test results. The battery may be removed or left in the analyzer until needed. When the battery is removed, the test results are canceled.

CHAPTER 2

BASIC OPERATION

1. Power Up

Before connecting the C4000, check for the correct line voltage. The line voltage label is located on the bottom of the unit. The on-off switch is on the back panel.

When the power is turned on, the display (LCD) message briefly reads:

Start-up messages

```
C4000 (C)1993 CADEX ELECTRONICS INC.
VERSION: 3.00P; ** DIAGNOSTICS PASS **
```

The display then shows the Target Capacity setting briefly, then switches to the Global Display. If the Battery Adapters are installed in Stations 1, 2 & 3, but not 4, the display shows:

Global Display

```
  EMPTY  EMPTY  EMPTY  ADAPTER?
=
```

The analyzer is now ready to service batteries in Stations 1, 2 & 3.

Note It is advised to install a Battery Adapter in all vacant stations. This prevents damage by static electricity.

Battery Adapters

The batteries interface with the C4000 through Battery Adapters. You can install, replace and reprogram the adapters while other batteries are being serviced. For more details on the various types of Battery Adapters, refer to CHAPTER 6 — BATTERY ADAPTERS.

2. Analyzing Batteries

Set Program

Before servicing a battery, select the desired program (refer to CHAPTER 3 — PROGRAMS & TARGET CAPACITY).

Set Target Capacity

Select the Target Capacity. If you are not certain what setting to use, select 80%. For more detail, refer to CHAPTER 3 — PROGRAMS & TARGET CAPACITY.

Verify correct battery setting

Check that the Battery Adapter is set to the correct battery parameters. With the display indicating EMPTY, press the appropriate Display Key. The display now indicates the setting of the Battery Adapter in question.

C4000 Battery Parameter Display For A NiCd Battery

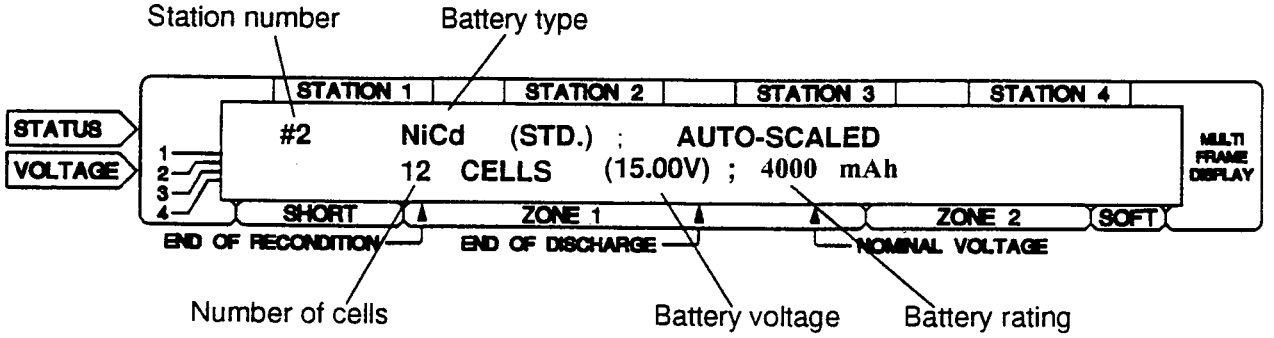


Figure 2.1

Viewing different display frames

Since not all information can be shown on one display frame, the battery parameters are contained in several frames. The basic information is shown in the first frame, followed by more detailed definitions in the subsequent frames.

To step through the frames, press the appropriate Display Key several times. For more details on the display, refer to CHAPTER 4 — STATUS INDICATORS.

Reverse polarity and short protection

The C4000 is electronically protected against reverse connection and short circuits. No harm is done to the equipment if the battery has a short or is accidentally connected in reverse polarity.

"Dead" batteries

If the battery to be serviced has no voltage reading, an initial brief charge by a designated charger is required. The C4000 will not start the program if battery voltage is not detected.

Connect battery

After selecting the program and target capacity, you are now ready to connect the battery. Battery connection is acknowledged with a beep tone. While the battery is being serviced, the yellow RUN LED is on.

Program Sequence

The program starts with discharge, followed by charge.

PRIME and AUTO

If the battery has no capacity (no energy), the program starts with charge.

CHARGE

On the CHARGE program, the battery commences with charge. No discharge is applied.

Method of battery analysis

It is not possible to obtain an immediate capacity reading by inserting a battery. The capacity is derived by discharging the battery at a calibrated current to the end-of-discharge threshold voltage. The elapsed time is measured and displayed as the derived battery capacity.

When the battery starts discharging, the Global Display reads "CAP: 0%". The flashing capacity figure indicates that the number is counting upwards. When the battery voltage has dropped to the end-of-discharge threshold, the discharge terminates. The readings stop flashing and the true capacity is then known.

Several capacity readings may be shown. If more than five discharge-charge cycles have been applied, the 2nd, 3rd, 4th and 5th readings indicate the latest four capacities. The first reading (Residual Capacity) remains visible at all times.

Definition of battery capacity

The capacity reading is the percentage of the manufacturer's battery rating. The rating is measured in mAh (milliampere per hour). For more information, refer to CHAPTER 11, "3. Battery Rating".

Example A fully-charged battery rated at 1000mAh must be able to provide a discharge current of 1000mA for one hour. If the battery can provide this current for that time, the derived capacity is 100%. If the battery can only provide the current for 30 minutes, the capacity is 50%.

Interrupt

When a battery is disconnected while in service, a beep tone sounds. If the battery is reconnected within five seconds, service resumes without interruption. If not re-connected, the Station resets to EMPTY in five seconds and the battery data is lost.

Pressing the Display Key during the five-second interrupt resets the Station immediately.

Changing control settings

Changing the Program Selector while a battery is serviced does not affect the program in progress. To restart with a different program, remove the battery and press the appropriate Display Key to reset the station. Select the new setting and re-insert the battery.

Changing the Target Selector during service is possible. Since the Target Capacity setting is read at the end of each discharge, the effect of changing the setting will depend on the battery's position in the program sequence at the time of change.

Full Load

Batteries requiring charge or discharge power in excess of the unit's capacity are put on a waiting queue. The display message for batteries on hold reads WAITING.

When the charge or discharge power becomes available, a battery that is waiting resumes service.

Note Energy from discharging batteries is used to charge the other batteries.

3. Evaluation of Battery Results

Evaluation by LEDs

PRIME and AUTO Each Station is equipped with RUN, READY and FAIL LEDs. During service, the RUN LED is on. When the program is completed and the battery has met or exceeded the Target Capacity, the READY LED lights up. If the Target Capacity has not been reached, the FAIL LED comes on. A flashing FAIL indicates incorrect battery voltage due to defective cells.

CHARGE Since no capacity reading is taken on the CHARGE program, the READY LED blinks when the battery is fully charged. For a summary of LED signals, refer to CHAPTER 4 — STATUS INDICATORS.

Evaluation by display

In addition to the RUN, READY and FAIL LEDs, the C4000 is equipped with an 80-character display.

Global Display The status of each battery in service is shown on the first line of the display. The average cell voltages are displayed in bar-graph form on the second line.

Detailed Display Pressing the Display Key allows you to get more detail on the battery services. Several capacity figures are shown on multi-cycle programs. Average cell voltage and battery Fault Codes (if present) are also displayed. For more information, refer to CHAPTER 5 — FAULT CODES.

CHAPTER 3

PROGRAMS & TARGET CAPACITY

Introduction

The CADEX C4000 features user-selectable programs with decision-making capabilities that evaluate the battery and apply an appropriate service to improve or restore a battery. This section explains the different applications, and recommends the best choice of program and target capacity settings to be used.

Selection

The programs are selected through the Program Selector Switches on the front panel of the C4000. You can set each Station to a different program.

Important Select the correct program before connecting the battery. Changing the setting after the battery is connected will have no effect.

Indicators

While the program is running, the RUN LED for that Station is on. The program is completed when the RUN LED turns off and either the READY or FAIL LED comes on (refer to CHAPTER 4 — STATUS INDICATORS).

1. Application Table

Table 3.1 summarizes the typical applications of program setting.

	PRIME	CHARGE	AUTO
WHEN TO USE IT	Prepare new batteries for field use. Condition batteries that have been in storage. Verify battery condition to support a warranty claim.	Fast-charge only. Top-up charge of partially discharged batteries.	Restore batteries affected by "memory". Identify marginally performing batteries. Weekly or monthly routine battery maintenance.
TIME (in hours) NiCd[1] NiMH[2] SLA[3]	 5 to 10 10 to 20 40 to 80	 1.5 3 10	 2.5 to 10 5 to 18 20 to 40

Table 3.1

[1]Time at Default C-Rate of 1C.
[2]Time at Default C-Rate of 0.5C.
[3]Time at Default C-Rate of 0.3C charge and 0.1 discharge.

2. Prime

When to use it

- Prepare new batteries for field use.
- Condition batteries that have been in storage.
- Verify battery condition to support warranty
- claim.

PRIME is used to condition new batteries prior to use. A new (or stored) battery may require several charge/ discharge cycles until peak performance is reached.

Program time

The time required may vary depending on the battery type. At a C-Rate of 1C, the program time is:

NiCd	5 to 10 hours
NiMH	10 to 20 hours
SLA	40 hours or longer.

For more information on C-Rates, refer to CHAPTER 11 — C-CODE TABLES.

How it works

The battery first discharges to the end-of-discharge threshold voltage and recharges. A second discharge-charge cycle is applied and its resulting capacity is compared with the first reading.

5 % improvement If the improvement is 5 % or higher, a further charge-discharge is applied. This cycle is repeated until the improvement is less than 5 %. At this percent, it is assumed that the battery has reached the peak performance. The program concludes with a final charge.

Very low-capacity battery A battery that cannot obtain a capacity of 5% is cycled four times. This feature allows additional priming cycles on a new battery that cannot accept a full charge at first.

Empty battery A fully-discharged battery will proceed with charge immediately.

Trickle charge After the service is completed, trickle charge is applied. If one or more cells within the battery are bad then the battery fails. No trickle charge is applied.

Indicators

Lights

- READY if the battery meets or exceeds the Target Capacity.
- FAIL if the battery cannot meet the Target Capacity.

Display

When the program is successfully completed, the Global Display shows the Final Capacity reading. By pressing the appropriate Display Key, the display shows additional information. If the battery failed, a Fail Code is shown (refer to CHAPTER 5 — FAULT CODES).

The Global Display shows a maximum of five capacity readings on PRIME. The first reading is the Residual Capacity, the middle readings are the Transitional Capacities and the last is the Final Capacity.

- **Residual Capacity** is the charge that is left before
- **Transitional Capacities** are the middle readings.
- **Final Capacity** represents the final reading.

3. Charge

When to use it

- Top-up partially charged batteries.
- Serves as a fast-charger.

Program Time

The time required may vary depending on the battery type. At a C-Rate of 1C, the charge time is:

NiCd	90 minutes typically
NiMH	3 hours typically
SLA	10 hours typically.

For more information on C-Rates, refer to CHAPTER 11 — C-CODE TABLES.

How it works

CHARGE fully charges a battery. After full charge is reached, trickle charge is applied to maintain full charge capacity. Full charge is detected by the Negative Slope method. Poorly matched cells that do not produce an adequate slope are timed out by the Plateau Timer. The combination of these two methods provides an accurate and safe means to terminate the fast-charge. No temperature sensing is required if the battery is serviced within the recommended temperature range.

Partially or fully charged batteries

The analyzer recognizes a partially or fully charged battery. On these batteries, the charge time is shortened accordingly. A shorter charge time also applies to batteries that have a low capacity.

Reverse Load Charge Method

Reverse Load Charge is used to promote the recombination of gases generated during the fast-charge of the NiCd and NiMH batteries. The Reverse Load Charge intersperses discharge currents between the charge pulses. The results are a cooler and more effective charge than conventional chargers. In addition, the "memory" phenomenon is reduced as the battery is stimulated while charging. Refer to "4. Auto" for definition of memory.

Note Reverse Load Charge is used for all charge and trickle charge functions.

Indicators

LEDs Blinking READY if the battery is fully charged (blinking indicates that no capacity evaluation was taken). FAIL if the voltage is too low.

Display When the program is successfully completed, the Global Display shows "DONE". If the battery failed, a Fail Code is shown (refer to CHAPTER 5 — FAULT CODES).

4. Auto

When to use it

Exercises batteries to maintain peak performance.

Reconditions those NiCd batteries that are unable to reach the Target Capacity.

Identifies and "weeds out" marginally performing batteries.

Applies battery maintenance for battery fleet.

AUTO is the recommended program for routine maintenance of NiCd batteries. Batteries that meet the Target Capacity are exercised to retain the optimal performance. Batteries that are unable to reach the target are reconditioned. This program is effective in restoring batteries with "memory".

Memory Memory is a crystalline build-up that forms when the battery is repeatedly recharged without sufficient discharge. This phenomenon occurs on NiCd batteries only and causes progressive capacity degradation.

Program Time

The time required may vary depending on the battery type. At a C-Rate of 1C, the program time is:

NiCd 2.5 to 10 hours
NiMH 5 to 18 hours
SLA 20 to 40 hours.

For more information on C-Rates, refer to CHAPTER 11 — C-CODE TABLES.

How it works

If Residual Capacity meets target

The battery is first discharged to one volt per cell during which the Residual Capacity is measured. If the capacity meets or exceeds the target, a final charge is applied. Typical program time is 2 to 3 hours

If Residual Capacity is below target

If the Residual Capacity is below target, the battery is fully recharged and a second discharge is applied to measure the full-charge capacity.

If second discharge meets target

If the second discharge meets the Target Capacity, the program concludes with a final charge. The READY LED comes on.

If second discharge capacity is below target

If the second discharge capacity is below target, Recondition is applied. The battery is fully recharged and discharged once more to measure the Final Capacity. A concluding charge follows.

Indicators

NiCd, NiMH

If the Final Capacity meets the target, the READY LED comes on. If below target, the FAIL LED comes on.

SLA

For SLA batteries, AUTO consists of 1 or 2 discharge/charge cycles. Recondition is omitted.

For more information on the NiCd battery, refer to a separate publication referred to as "***Characteristics of Rechargeable Batteries***".

Recondition

Recondition is a controlled deep discharge that removes the crystalline build-up, or "memory", on the cell plates.

5. Custom

The Custom Program is used if a special function or a sequence of functions is required, such as:

- Discharge only for purpose of shipping or storage
- Long-term reliability test by cycling the battery until the capacity drops below the set Target Capacity.

The information on this program is extensive. Refer to CHAPTER 9 — CUSTOM PROGRAMS for details.

6. Standby

Standby automatically runs 30 days after the battery has completed AUTO, PRIME or CHARGE.

Why is it needed

If a NiCd battery is left on trickle charge for prolonged periods, deterioration due to "memory" occurs (refer to "4. Auto" for definition of memory).

On the other hand, if a fully-charged battery is placed on the shelf, it is subject to significant self-discharge.

Self-discharge

Approximately 10% of the battery's charge is lost in the initial 24 hours. The self-discharge is reduced to 10% per month thereafter. At higher storage temperatures, the self-discharge rate is higher. Likewise, older batteries have a higher self-discharge than a newer one.

What does it do

- Maintains batteries that must be kept charged for unscheduled use.
- Makes fully-charged batteries available for equipment rental.
- Verifies long-term battery performance.

How it works

Standby applies a discharge-charge cycle after the battery has been on trickle charge for 30 days. The setting of the Program Selector has no effect on the Standby operation. The capacity readings are displayed as per the PRIME program.

7. Target Selector Setting

The Target Capacity is set through the Target Selector Switch. The setting is global and applies to all Stations. Individual Target Capacity settings are possible through the menu-driven interface. Refer to CHAPTER 8 — UTILITIES, " 4. Station Target Capacity".

Select 80% for most applications

The Target Selector lets you set the minimum acceptable level you must obtain from a battery. If uncertain what setting to use, select 80%.

Note The Target Capacity setting does not affect the charge level; the batteries are ***always*** fully charged regardless of the setting.

The suggested Target Capacity settings are as follows:

60%, 70% The low-end Target Capacity settings are used for applications where the battery power demand is not critical or is of brief duration. These settings pass the largest number of batteries when serviced.

80% This is the most common Target Capacity setting. It satisfies the need for adequate energy reserve as well as economical use of the battery fleet.

90%, 100% The high-end Target Capacity settings are used for critical applications that require maximum energy reserve and high reliability. These settings pass the least number of batteries when serviced.

8. Calculation of Target Capacity

To establish a workable target setting for your requirement, the following evaluation is recommended:

- Use a battery with a known working-capacity reading
- Fully charge the battery and use it in a normal field situation
- Measure the remaining capacity after the routine shift.
- Select PRIME or AUTO and insert the battery. The first discharge reveals the Residual Capacity. The second discharge is the Full Capacity.
- With the Residual and Full Capacities known, the consumed energy can be calculated by deducting the Residual Capacity from the Total Capacity.

Example of Target Capacity calculation

Working Capacity of battery when fully charged	**100%**
Residual Capacity after a routine shift	**20%**
Consumed Capacity	**80%**

Recommended Target Capacity setting

If the Residual Capacity is less than 20%, the Target Capacity should be increased by 10%. Likewise, if the Residual Capacity is 30% and higher, the Target Capacity may be reduced by 10%.

CHAPTER 4

STATUS INDICATORS

Introduction

The light-emitting diode (LED) provides the user with a quick overview of the battery test results. The battery status is indicated for each Station by the LEDs as follows:

RUN	(yellow)	**Program in progress**
READY	(green)	**Program completed**
FAIL	(red)	**Test results negative.**

Detailed battery test results are shown on the 80-character display.

1. LED Indicators

RUN	*steady*	Battery service in progress.
	*blinking**	Below temperature range for charge; will proceed automatically when temperature rises to acceptable level.
READY	*steady*	Battery ready; capacity not available or capacity compared to target setting
	blinking	Battery ready; CHARGE mode only.
FAIL	*steady*	Program completed; Target Capacity not met.
	blinking	Battery voltage fault; cannot be corrected.
POWER	*steady*	Analyzer operational; normal condition.
	blinking	Analyzer is on hold because its internal temperature is above operating range; resumes when normal. ▪ Temperature trigger point: 70°C (158°F). ▪ Minimum hold time: 1 minute.
READY and FAIL	*blinking**	Battery hot; program terminated (CHARGE program only).
MENU	*steady*	Menu mode. Batteries in service are not disrupted by the menu but resume service as usual.

* with temperature sensor option only

2. Audible Tone Signals

The C4000 Analyzer produces a variety of audible signals to mark events such as buttons pressed or programs ending. The signals and the events are listed below.

Single beep tone:

- Battery connected (long beep)
- Display Key pressed (short beep)
- Menu Key pressed (short beep).

Triple beep: (High pitch) *Ready*

PRIME/AUTO: Target Capacity met or exceeded.

CHARGE: Full charge done.

Triple beep: (Low pitch) *Ready*

PRIME/AUTO: Target Capacity not met.

Continuous tone

Shorted battery, not serviceable. Remove battery or press Display Key to stop tone.

Wailing sound

Wrong polarity. Remove battery and reverse connection.

Fading tone (gong)

New battery parameters stored in Battery Adapter.

Low tone

New battery parameters not accepted, or invalid parameters.

3. Status Indicator Tables

Table 4.1 summarizes the LED and sounder schedules.

	CONDITION	LEDs	SOUNDER	MODE	COMMENTS
NO BATTERY	Open terminal	RUN off READY off FAIL off	silent	reset	Station resets when battery removed.
BATTERY INSERTED	Battery in service	RUN ▬▬▬ READY off FAIL off	single beep	active service	Beep tone when battery inserted.
BATTERY READY (CHARGE)	Normal battery voltage	RUN off READY ▬ ▬ ▬ FAIL off	triple beep	trickle charge	Target capacity not used in CHARGE mode.
BATTERY READY (PRIME or AUTO)	Battery capacity meets target capacity	RUN off READY ▬▬▬ FAIL off	triple beep	trickle charge	High-pitch triple beep if READY; low pitch if FAIL.
	Battery fails to meet target capacity	RUN off READY off FAIL ▬▬▬	silent	trickle charge	If program was PRIME, try AUTO.
REVERSE POLARITY/SHORT	Leads are reversed or battery has low voltage	RUN off READY off FAIL ▮▮▮▮▮▮▮▮▮	wailing	no charge	Check leads. Charge battery in manufacturer's specified charger. Do not leave battery unattended.
LOW VOLTAGE	Battery has shorted cell(s)	RUN off READY off FAIL ▮▮▮▮▮▮▮▮▮	silent	no charge	Partial short, low voltage or depressed V. Discard battery.
SOFT BATTERY	Battery voltage rises too high	RUN off READY off FAIL ▮▮▮ ▮ ▮▮▮	silent	no charge	Charge terminated, discard battery.
INTERMITTENT	Unable to clamp battery voltage	RUN off READY off FAIL ▮ ▮ ▮	silent	no charge	Check condition.

Table 4.1

Temperature Sensor (optional)

The sensor inhibits fast charging outside the operational temperature range. Battery sensing is not required if the batteries are serviced within the specified temperature range.

The temperature sensor measures the cell temperature of the battery. The sensor may be part of the battery assembly or installed externally.

	CONDITION	LEDs	SOUNDER	MODE	COMMENTS
COLD BATTERY	Temperature below +10°C (+50°F)	RUN ■■■ READY off FAIL off	silent	trickle charge	Trickle charges until room temp. is reached, then fast charge.
HOT BATTERY TERMINATED	Battery reaches +45°C (+113°F)	RUN off READY [1] ■■■ FAIL ■ ■	silent	trickle charge	Battery is considered fully charged.

Table 4.2

Thermal Protection

The C4000 is thermally protected by a fan and an internal thermal cutoff.

Fan The cooling fan engages at 45°C (113°F) and turns off at 35°C (95°F).

Heat Rail If the internal heat rail exceed 70°C (158°F), the service is suspended and resumes when the temperature has dropped (refer to Table 4.3).

System Fault

The C4000 performs a number of diagnostic tests when turned on.

If a system fault occurs during operation, the LEDs may flash at random and the unit will not respond as usual. Turn the power off and on again. If the condition persists, do not attempt to service any batteries. Turn the unit off and call for service.

[1]CHARGE mode only.

	CONDITION	LEDs	SOUNDER	MODE	COMMENTS
OVER TEMPERATURE	Heat rail too hot	POWER ■■■■■■■■■	silent	no charge or discharge	Service resumes when temperature normal.
SYSTEM ERROR	System fault	Any LEDs on or off at random	on or off	non valid	Micro-controller fault. Turn unit off. If condition persists when power reapplied, call for service.

Table 4.3

4. Display (LCD)

The LCD (Liquid Crystal Display) features three major display frames: Global, Detailed and Menu.

Global Display

The **Global Display** shows the status all four batteries in service and their average cell voltages.

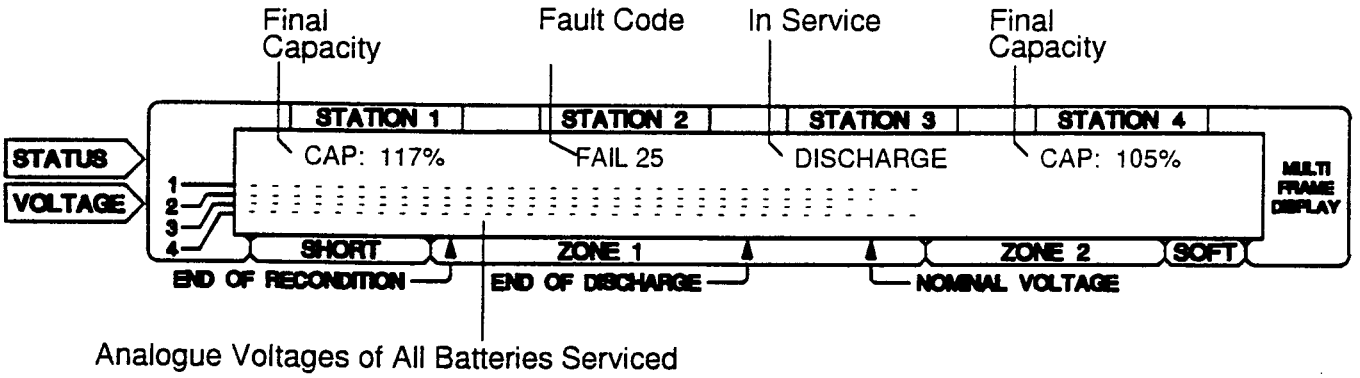


Figure 4.4

First line The first line is divided into four fields, one for each Battery Station. The status of each battery is shown.

In the above example, the battery in Station 1 achieved a Final Capacity of 117%; battery 2 failed; battery 3 is currently discharging; and battery 4 has reached a Final Capacity of 105%.

Second line The second line displays the average cell voltages of the batteries in bar-graph form. Each battery occupies one line. The voltage range of the bars is divided into SHORT, ZONE 1, ZONE 2 and SOFT.

While on charge, only batteries which enter and remain in Zone 2 are functioning correctly. Batteries with voltages in other zones fail. A corresponding Fault Code is displayed to indicate the nature of the fault. Refer to CHAPTER 5 — FAULT CODES for an explanation of the codes.

Detailed Display

The Detailed Display is generated by pressing the Display Key corresponding to the Station. Battery status, capacity readings, charge & discharge current, and explanations of Fault Codes (if any) can be seen.

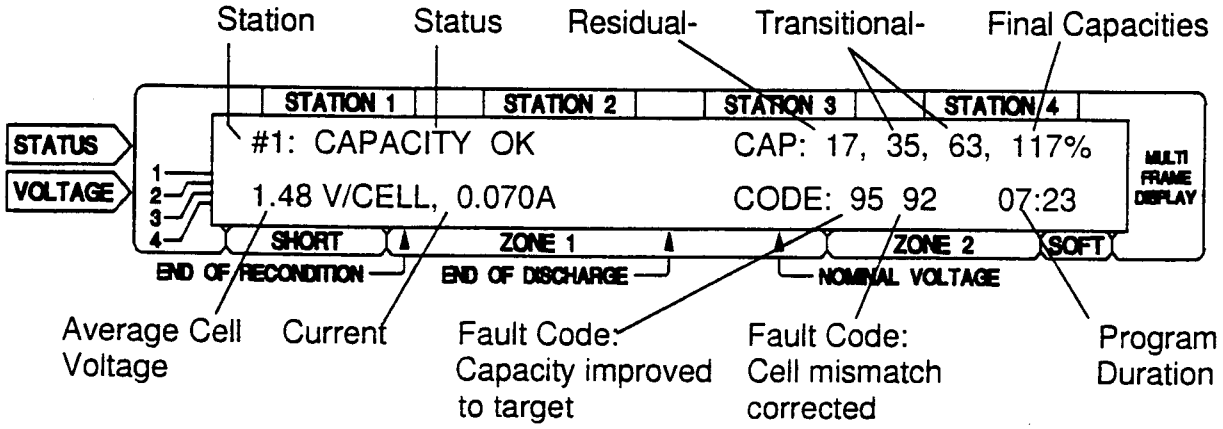


Figure 4.5

Our example above shows the readings of the battery tested. The program is completed and the battery is in trickle charge. The capacities are: 17% (residual), 35% and 63% (transitional), and 117% (final). The average cell voltage of 1.48V/cell is shown.

Current The current indicated is the trickle charge current. When discharging, a [-] symbol appears in front of the number.

Fault Code The battery produced Code 95 and 92. To obtain an explanation of the codes, press the Display Key. Press again to explain additional codes. After all Fault Codes have been spelled out, the display reverts to the Global Display. If unattended for one minute, the display will also revert to Global.

Program Duration The elapsed program time is displayed on the lower right. This feature is only audible with the Option-P.

Menu Display The **Menu Display** allows you to view and modify the battery parameters stored in the Battery Adapters. Refer to CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS for more details.

5. Display Messages

There are two types of messages: the short ***Global Display*** message and the longer ***Detailed Display*** message. The Global Display message can often be further clarified by pressing the appropriate Display Key to get the Detailed Display message.

Global Display Messages

Message	Explanation
ADAPTER	= No Battery Adapter or adapter not recognized
BAD ADAP	= Bad Battery Adapter or Custom Adapter
CAP:xxx	= PRIME or AUTO program completed, last capacity shown
CHARGE	= Charge cycle in progress
COOLING	= Battery cooling cycle
DISCHARGE	= Discharge cycle (battery capacity is measured)
DONE (12)	= Cell mismatch, charge terminated by Plateau Timer
DONE	= Battery fully charged in CHARGE program
EMPTY	= No battery connected or battery not recognized
FAIL xx	= (See CHAPTER 5 — FAULT CODES)
FUSE?	= Blown fuse or bad driver
HOLD	= Charge program halted
HOLDING	= Station holding (over temperature; heat rail at 70°C (158°F))
INTERRUPT	= Cycle interrupted, status held for 5 seconds
INV CODE	= Invalid C-Code, examine C-Code
INV PROG	= Invalid custom program
INV TYPE	= Invalid Battery Adapter or Custom Adapter
NULL CODE	= Null Code, enter valid C-Code
RECON	= Recondition cycle in progress
REST	= Station in a rest cycle
SHORT/REV	= Shorted battery or reversed polarity
SHORTED!	= Shorted battery (Code 22)
WAITING..	= Power supply at full load, will resume

Detailed Display Messages

Message	Explanation
1ST CHARGE [AUTO]	= First charge cycle in AUTO program
2ND CHARGE [AUTO]	= Second charge cycle in AUTO program
1ST DISCHARGE [AUTO]	= First discharge cycle in AUTO program
2ND DISCHARGE [AUTO]	= Second discharge cycle in AUTO program
AUTO FAILED [AUTO]	= Battery failed in AUTO program
BAD ADAPTER - RE-INSERT	= Faulty Battery Adapter or Custom Adapter
BATTERY FAILED	= (Code 18)
BATTERY HOT (ZONE 1)	= (Code 56)
BATTERY HOT (ZONE 2)	= (Code 58)
BATTERY SHORTED	= (Code 22)
CAPACITY OK	= Battery capacity has been met or exceeded
CAPACITY IMPROVED TO TARGET	= (Code 95)
CELL MISMATCH (POOR NEG.SLOPE)	
CELL MISMATCH CORRECTED	= (Code 92)
CHARGE [STANDBY]	= Charge cycle in STANDBY mode
CHARGE COMPLETED [CHARGE]	= CHARGE program completed
CHARGE CURRENT NOT MET	= (Code 64)
CHARGE CURRENT REDUCED	= (Code 18A)
CHARGE CYCLE [PRIME]	= Charge cycle in PRIME program
CHARGE (HELD)	= Charge held; unit hot or at full load
BATTERY MAY BE SULPHATED	= (Code 20) Lead Acid
CHARGE ONLY [CHARGE]	= Charge in CHARGE program
CHARGE TERMINATION BY PLATEAU	= (Code 12) Lead Acid
CHARGE TIME-OUT (IN ZONE 2)	= (Code 44)
CHARGE TIME-OUT	= (Code 44) Lead Acid
DELTA TEMP CHARGE TERMINATION	= (Code 54)
DISCHARGE [STANDBY]	= Discharge cycle in STANDBY mode
DISCHARGE CURRENT NOT MET	= (Code 62)
DISCHARGE CYCLE [PRIME]	= Discharge cycle in PRIME program
DISCHARGE(HELD)	= Discharge held; unit hot or at full load
DISCHARGE TIME-OUT	= (Code 42)
FAN OR SENSOR FAILURE	= (Code 66)
FINAL CHARGE [AUTO]	= Final charge cycle in AUTO program
FINAL DISCHARGE [AUTO]	= Last discharge cycle in AUTO program
INTERMITTENT BATTERY	= Battery opened 5 times in 1 min. (Code 29)
INVALID TYPE ADAPTER	= (Examine adapter type)
INVALID C-CODE	= (Examine C-Code)
LOW VOLT (ZONE 1 PLATEAU TIMER)	= No negative slope in Zone 1 (Code 25)
LOW VOLT (ZONE 1 NEGATIVE SLOPE)	= Negative slope in Zone 1 (Code 26)
LOW VOLTAGE (ZONE 1 TIME-OUT)	= TIME-OUT in Zone 1 (Code 27)

LOW VOLTAGE (ZONE 1 DELTA TEMP)	= (Code 52)
NO ADAPTER	= No Battery Adapter, or adapter not recognized
NOT ACTIVE - INSERT A BATTERY	= No battery connected, or battery not recognized
NULL C-CODE - ENTER BATTERY CODE	= (Enter valid C-Code)
OPEN FUSE OR BAD DRIVER	= (Code 60)
OVER VOLTAGE	= High Voltage
PLATEAU TERMINATION CORRECTED	= (Code 92) Lead Acid
PRIME FAILED [PRIME]	= Battery failed in PRIME program
RECON CHARGE	= 8 min. 32s trickle charge after Recondition
RECON (HELD)	= Recondition held; unit hot or at full load
RECONDITION TIME-OUT	= (Code 46)
RECONDITIONING	= Reconditioning in progress
RESERVE OK [AUTO]	= 1st discharge on AUTO meets target capacity
SHORTED OR REVERSED!	= **SHORTED:** Atttempt to charge battery with designated charger for a few minutes = **REVERSED!:** Reconnect correctly
SOFT BATTERY	= Battery exceeds allowable voltage (Code 28)
TARGET CAPACITY NOT MET	= (Code 15)
VERY LOW VOLTAGE (ZONE 1 TIME-OUT)	= (Code 23, 24)

CHAPTER 5

FAULT CODES

1. Application Tables

The CADEX C4000 is capable of identifying battery deficiencies and faults. These characteristics are categorized in Fault Codes. Explanation of the Fault Codes are shown on the display upon request.

The Application Table on the following pages summarizes the Fault Codes. Further explanations of each code are described in the subsequent paragraphs.

Fault Code	Definition	Reason	Battery Chemistry	What to do
12	Cell mismatch	No adequate Negative Slope	NiCd	Battery is serviceable. Observe performance.
15	Target Capacity not met	Inadequate performance	NiCd, NiMH, SLA	Use AUTO for NiCd. If all fails, discard battery.
18	Charge current reduced	■ New battery, not formatted ■ Prolonged storage ■ Charge current too high	NiCd, NiMH	Battery may correct itself with use.
20	High battery impedance	High battery voltage during charge	NiCd, NiMH, SLA	Battery not serviceable
21/22	Shorted or reversed	■ Battery totally discharged ■ Reversed battery leads ■ Battery shorted	NiCd, NiMH	• Charge prior to service • Reverse Polarity • Discard battery
23/24	Very low voltage	Some cells are shorted. 1 min and 10 min time-out*	Mainly NiCd	Discard battery
25	Low voltage, cell mismatch	Shorted and Uneven cells. Charge terminated by Plateau Timer	NiCd	Discard battery
26	Low voltage, cells are matched	Shorted cells. Charge terminated by negative slope	NiCd	Discard battery
27	Low voltage, charge time-out	Battery too large for allotted charge time	NiCd, NiMH	Check C-Code setting. If correct, discard battery.
28	Soft battery	Battery voltage rises too high during charging	NiCd, NiMH	Try again. Discard if battery fails again
29	Intermittent battery	■ Poor electrical contact ■ Faulty cell	NiCd, NiMH	Check C-Code setting and contacts. Discard if all fails.

Table 5.1

*Time indicated is based on a C-Rate of 1

Fault Code	Definition	Reason	Battery Chemistry	What to do
42	Discharge time-out	Capacity exceeds 250% capacity	NiCd, NiMH	Check battery rating within C-Code
44	Charge time-out	Battery too large for allotted charge time	NiCd, NiMH	Check battery rating within C-Code
46	Recondition time-out	Allotted Recondition time is too long due to: ■ Cell mismatch ■ Battery protection device ■ Recondition current too low	NiCd, NiMH	Check battery rating within C-Code
	Option			
52	Low voltage. Charge termination by temperature	Shorted cells, charge terminated by delta temperature rise	NiCd, NiMH, SLA	Discard battery
54	Normal voltage; Charge termination by temperature	Charge terminated by delta temperature rise. Battery is considered fully charged	NiCd, NiMH, SLA	Use battery as normal
56	Low voltage, hot battery	Service terminated, battery reached 45^0C (113^0F)	NiCd, NiMH, SLA	Discard battery
58	Normal voltage, hot battery	Service terminated, Battery reached 45^0C (113^0F). Battery is considered fully charged.	NiCd, NiMH, SLA	Use battery as normal
60	Open fuse or bad driver	■ Battery fuse is open ■ Battery has high impedance ■ Battery is sulfated	• Any battery • NiCd, NiMH • SLA	• Replace battery fuse • Repeat or discard battery • Discard battery
62	Discharge current not met	Battery or driver cannot provide the requested discharge current due to: ■ Wrong C-Code ■ Faulty battery ■ Open fuse ■ Faulty driver	NiCd, NiMH, SLA	Try battery on a different Station. • Check C-Code • Try different battery • Replace battery fuse • Call for service
64	Charge current not met	Battery or driver cannot provide the requested discharge current due to: ■ Wrong C-Code ■ Faulty battery ■ Open fuse ■ Faulty driver	NiCd, NiMH	Try battery on a different Station. • Check C-Code • Try different battery • Replace battery fuse • Call for service
92	Cell mismatch corrected	After several discharge-charge cycles the cells adapted to each other	NiCd, NiMH	Use battery as normal
95	Capacity improved to target	Exercise or recondition improved the capacity to target	NiCd, NiMH, SLA	Use battery as normal

Table 5.2

2. Correctional Faults

Correctional Faults allow the program to proceed but result in a Fault Code as a caution to the user.

Note Batteries with correctable faults may improve with the PRIME or AUTO program. If the battery is corrected as a result of the programs, the Fault Code changes to Corrected Fault Code. Refer to "6. Corrected Faults" in this Chapter.

Code 12
CELL MISMATCH
(POOR NEG. SLOPE)

Reason Cells are mismatched. The cells reach full charge at different times. This deficiency reduces the negative slope effect on the NiCd. The charge cycle is terminated by the Plateau Timer. The program proceeds to the next cycle as normal. For SLA , the plateau charge time-out occurred before specified full charge conditions were met

Battery type Code 12 only applies to NiCd batteries.

What to do If the capacity reading is acceptable, continue using the battery. Monitor the performance of the battery.

Code 15
TARGET CAPACITY
NOT MET

Reason Final capacity is below target. Code 15 is shown at the conclusion of the program. Possible reasons:

- Battery is overrated
- Memory effect on NiCd due to lack of maintenance
- Battery has been damaged by a poorly designed charger that heat up battery causing the battery to overheat.
- Old age

Battery Type Code 15 applies to all batteries

What to do NiCd's with memory may be corrected with the AUTO program. If all else fails, discard battery.

Over-rated batteries

It has been noted that some battery manufacturer over-rate their batteries. When you service these batteries at over-rated discharge currents, the capacity readings will be disappointingly low. ***Do not blame the C4000 for the low readings!*** Rather, contact your vendor.

What to do If a battery has been over-rated, select a lower charge and discharge current. Use your judgment in selecting a more appropriate current rating. CADEX recommends a current reduction of 10% to 15%.

Code 18
CHARGE CURRENT REDUCED

Reason Battery terminal voltage rises too high during charging. Possible reasons:

- Charge current is set too high for battery type
- Battery is new and has not been properly formatted
- Battery has been in prolonged storage
- Battery is too cold
- Battery lacks electrolyte
- Battery is not designed for fast-charge

New battery Code 18 may be caused by incomplete formatting of the battery. Formatting is part of the manufacturing process. Some manufacturers expect the batteries to reach full performance potential after 50 to 100 discharge-charge cycles.

Old battery Code 18 may be caused by a cell defect or be due to prolonged storage. Storage of NiCd batteries causes the electrolyte to collect at the lowest point. The electrolyte is redistributed by applying a few discharge-charge cycles, a prolonged trickle charge or both.

How it Works When Code 18 appears, the charge is discontinued. On PRIME and AUTO, the battery is discharged and recharged at half of the set charge current. All subsequent charge currents are performed at the reduced rates. If the battery voltage rises too high again, Code 28 is displayed.

Note: Code 18 does not apply to CHARGE

Battery Type Code 18 applies to NiCd battery.

What to do If the capacity reading is acceptable, continue using the battery. Monitor the performance of the battery.

3. Voltage Faults

Voltage faults are caused by shorted cells in the battery pack. If this occurs, the battery can no longer be used. Attempting to replace the faulty cells have failed in the past as the replacement cells are not matched with the existing cells.

Code 20 to 29 indicate different types of cell deficiencies in battery packs.

Code 20
HIGH IMPEDANCE

Reason Battery cannot accept charge. Possible reasons:

- Cell is dry (NiCd, NiMH)
- Cell is sulfated (SLA)

Battery type Code 20 applies to all batteries

What to do Check that the Battery Adapter is programmed to the correct number of cells. If all fails, discard battery.

Code 21 or 22
SHORTED OR REVERSED

Reason Battery is either shorted or connected backwards. No charge or discharge is applied.

Battery type Code 21 & 22 applies to all batteries

What to do

ensure battery leads are connected properly.

If completely discharged (no terminal voltage), charge the battery with a designated charger for a few minutes then connect to the C4000.

Code 23
VERY LOW VOLTAGE (ZONE 1 TIME-OUT)

Reason Charge time-out in Zone 1 after 1 minute[1] . Battery has shorted cells.

Battery type Code 23 is most common with NiCd and NiMH batteries.

What to do Discard battery.

[1]Time indicated is based on a C-Rate of 1

Code 24
VERY LOW VOLTAGE (ZONE 1 TIME-OUT)

Reason Charge time-out in Zone 1 after 10 minutes[1]. Battery has shorted cells.

Battery type Code 24 is most common with NiCd and NiMH batteries.

What to do Discard battery.

Code 25
LOW VOLT (ZONE PLATEAU TIMER)

Reason Charge termination in Zone 1 through Plateau Timer. Battery has shorted cells. Remaining cells accept charge but are mismatched, preventing Negative Slope at full charge.

Battery type Code 25 is most common with NiCd batteries

What to do Discard battery.

Code 26
LOW VOLT (ZONE 1 NEGATIVE SLOPE)

Reason Charge termination in Zone 1 through Negative Slope. The correct battery voltage cannot be obtained due to shorted cells. Remaining cells accept charge and appear to be matched.

Battery type Code 26 is most common with NiCd batteries.

What to do Discard battery.

Code 27
LOW VOLTAGE (ZONE 1 TIME-OUT)

Reason Charge termination in Zone 1 through time-out-timer. The correct voltage cannot be obtained in the allotted time frame. Fast-charge is terminated by timer. Possible reasons:

- Shorted cells
- Battery capacity too large for set charge current
- Number of cells not entered correctly

Battery type Code 27 is most common with NiCd batteries

What to do Check correct C-Code setting. If all fails, discard battery.

[1] Time indicated is based on a C-Rate of 1

Code 28
SOFT BATTERY

Reason Battery voltage rises too high during charging. The program terminates. Possible reasons:

- Charge current is set too high for battery type
- Battery has been in prolonged storage
- Battery is too cold
- Battery lacks electrolyte
- Battery is not designed for fast-charge

Battery type Code 28 is most common with NiCd batteries

What to do Check correct C-Code setting. Repeat the program. If all fails, discard battery.

Code 29
INTERMITTENT BATTERY

Reason Battery disconnects and reconnects itself five times in one minute. Possible reasons:

- Poor electrical contact
- Cell is dried up
- Battery is sulfated (SLA)

Battery type Code 29 applies to all batteries

What to do Check electrical contacts. If all fails, discard battery.

EMPTY

No battery connected or battery is not recognized.

Reason

- Battery has open connection.
- Contacts are misaligned or leads are open.
- Battery with On/Off switch is in OFF position.

What to do

- Check electrical contacts
- Try different battery
- Briefly short terminals of Battery Adapter without battery connected to check if short is recognized

4. Timing Faults

Each cycle is given a time limit in which to complete the task. If the task cannot be completed in the time frame allotted, a Fault Code is generated.

Code 42
DISCHARGE TIME-OUT

Reason Discharge time exceeds 250% (2:30h)[1] . Program is terminated. Possible reasons:

- Battery rating set too low.
- Battery capacity too high

What to do Use correct battery ratings.

Code 44
CHARGE TIME-OUT (IN ZONE 2)

Reason Charge termination in Zone 2 through total time-out-timer. Fast-Charge exceeds the allotted time limit. Program is terminated. Possible reasons:

- Battery rating set too low.
- Battery capacity too high

What to do Use appropriate battery ratings

Code 46
RECONDITION TIME-OUT

Reason Recondition discharge exceeds allotted time. Program proceeds to next step. Possible reasons:

- Recondition discharge current set too low
- Strong cells of a poorly matched battery pack prolong deep discharge
- Electronic protection device in the battery prevents deep discharge

What to do No corrective action required.

[1] Time indicated is based on a C-Rate of 1.

5. Temperature Criteria (Optional)

If batteries are serviced under extreme temperature conditions, temperature sensing is recommended. Temperature sensing is optional and is not required under normal temperature conditions.

Code 52
LOW VOLTAGE (ZONE 1 DELTA TEMP)

Reason Charge is terminated in Zone 1 through Delta Temperature. Battery voltage is too low. Cells exhibit a rapid rise in temperature. Program is terminated.

What to do Discard battery.

Code 54
DELTA TEMP CHARGE TERMINATION

Reason Charge is terminated due to rapid rise of cell temperature in Zone 2. Battery voltage is normal. Program proceeds to next step. Battery is considered fully charged.

Full-charge detection through Delta Temp and Negative Slope coincide at about the same time when the battery reaches full-charge. Either method may terminate the fast-charge.

What to do Use battery as normal.

Code 56
BATTERY HOT (ZONE 1)

Reason Battery temperature has reached 45°C (113°F) in Zone 1. Battery voltage is too low. Program is terminated.

What to do Discard battery.

Code 58
BATTERY HOT (ZONE 2)

Reason Battery temperature has reached 45°C (113°F) in Zone 2. Battery voltage is normal. Program proceeds to next step. Battery is considered fully charged. Possible reasons:

- Battery is old and has poor performance
- Battery has high self discharge
- High internal resistance (common to some ultra high capacity NiCd cells)

What to do Observe self-discharge. If self-discharge is less than 30% in 24 hours and the capacity reading is acceptable, the battery is usable.

6. Electrical Limitations

The battery in service must be able to deliver the current being requested. Likewise, the C4000 must provide the charge and discharge requirements that is commanded. If, due to a weak battery or faulty power supply, the current cannot be delivered, a Fault Code is generated.

Code 60
OPEN FUSE OR
BAD DRIVER

Reason

- Fuse in Station is open
- Bad driver.
- NiCd, NiMH battery has high impedance
- SLA battery is sulfated

What to do Try a different battery. If the problem persists, replace the battery fuse as described in CHAPTER 13, "2. Replacing Fuses". If all fails, call for service.

Code 62
DISCHARGE
CURRENT NOT MET

Reason The battery or driver cannot provide the charge current requested. Possible reasons:

- Faulty battery
- Bad driver or hardware fault
- Wrong C-Code
- Open battery fuse

What to do

- Try a different battery in same Station.
- Check battery fuse and replace if necessary
- Lower discharge current

Code 64
CHARGE CURRENT NOT MET

Reason
Power supply, battery or driver cannot provide the charge current required. Possible reasons:

- Low line voltage
- Power supply problem
- Charging 12 cell battery packs at high current
- Faulty battery

What to do

- Try a different battery in same Station
- Lower charge rate

7. Corrected Faults

A battery condition or problem that corrected itself during the service is marked with a Correctional Fault Code. If this happens, The battery can be used as normal ; however, You should observe the battery during its service life.

Code 92
CELL MISMATCH CORRECTED

Reason The cell mismatch corrected itself by applying discharge-charge cycles. Code 92 replaces Code 12. This phenomenon is common with new batteries.

What to do Use battery as normal. Observe performance.

Code 95
CAPACITY IMPROVED TO TARGET

Reason Exercise or Recondition improved the capacity to target. Code 95 replaces Code 15.

CHAPTER 6

BATTERY ADAPTERS

Introduction

The CADEX C4000 uses interchangeable Battery Adapters to accommodate different battery types. Available for all major batteries, these adapters can be reprogrammed to different battery types as required.

The battery parameters are stored in the Battery Adapters. Once entered, the parameters are retained in a memory chip in the adapter.

The Battery Adapters may be mixed and matched as required; exchanging and reprogramming of the adapters can be done while other batteries are being serviced.

The use of Battery Adapters enables the C4000 to accommodate a large variety of battery types. A list of current Battery Adapters is shown in the APPENDIX. If an adapter is not listed, contact CADEX ELECTRONICS INC.

1. Battery Adapter Styles

The C4000 offers three types of Battery Adapters:

- **Configured Cups**
- **Smart Adapters,** either configured or universal
- **Smart Cables.**

All adapters contain a memory chip that retains the battery parameters. The battery parameters are retained even when the power is off or when the adapter is removed from the C4000.

CONFIGURED CUP	SMART ADAPTER Configured or Universal	SMART CABLE Configured or Universal

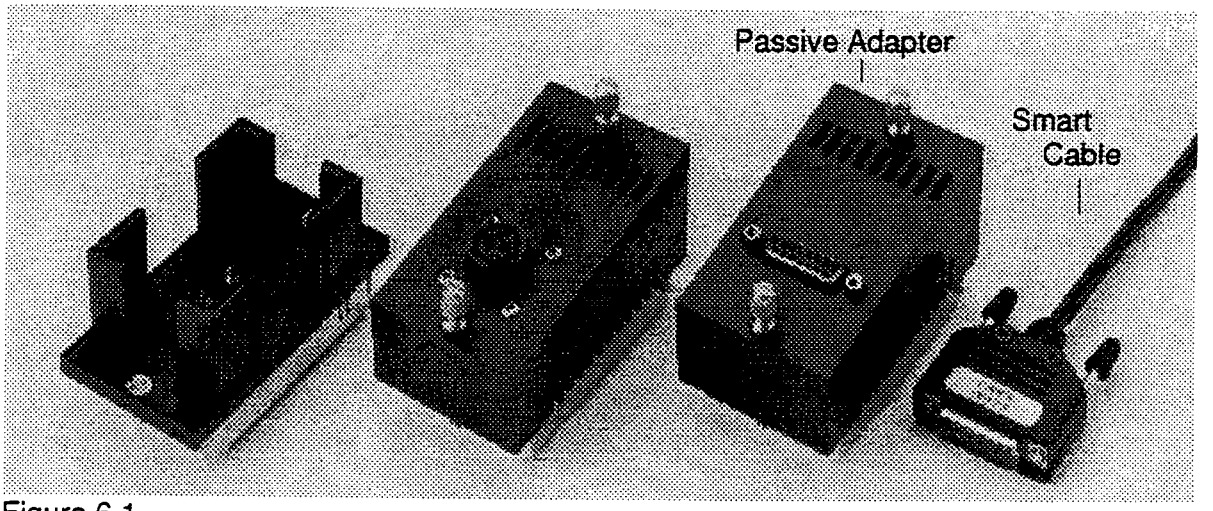


Figure 6.1

Battery slides into cup. The C-Code may be changed for batteries with different capacities.	Accommodates batteries that cannot fit into a cup. Cable may be fixed or detachable.	Adapter is passive; the cable itself is programmable. Cables may be preconfigured with appropriate ends.

Configured Cups

Configured Cups are used for smaller batteries.

This type of adapter is factory programmed to a specific battery model. The battery parameters can be reprogrammed in the field to suit other batteries with a different voltage and/or mAh rating.

Smart Adapters

Smart Adapters are used for batteries that are too large or complex for Configured Cups. These adapters consist of a cable and a custom-designed battery connector. It can be reprogrammed as required.

Smart Cables

Smart Cables differ from the Smart Adapter in that the memory chip is embedded in the cable. The cable is open-ended and may be terminated with appropriate battery connectors. Smart Cables are used with a Passive Adapter.

The Smart Cable must be programmed before it can be used. Refer to CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS.

2. Installation

The Battery Adapters can be installed, removed and reprogrammed while other batteries are being serviced. Observe static precautions while installing Battery Adapters.

Caution When the Station is open, do not touch the card-edge connector or gold contacts of Battery Adapters, as static charge could cause damage to the micro-circuit.

When installing and removing the adapters, guide the adapter into the card-edge connector. Gently press it down until level, and tighten the screws.

Be careful When removing the adapter, loosen screws and gently lift off the adapter using both hands. Do not use force. Avoid jamming.

Bad Adap/Inv Type

If the LCD reads "BAD ADAP" or "INV TYPE", remove and reinsert the Battery Adapter. If the error persists, turn the unit off, then on again. If neither action clears the error, the Battery Adapter needs service.

3. Battery Adapter Errors

When a Battery Adapter is installed, the analyzer reads the C-Code in the adapter's memory chip. If the analyzer detects a fault, the LCD displays an appropriate message. The following table shows the most common messages.

ADAPTER? or BAD ADAP	No Battery Adapter is installed, or the Battery Adapter is not recognized. Check the contacts of the Battery Adapter and the card-edge connector of the analyzer. Observe static precaution when touching the contacts of the card-edge connector. The possible problems are: ■ Custom Adapter ■ Faulty adapter ■ Battery Adapter was not factory initialized ■ Battery Adapter has only a Null Code. Enter the battery parameters before use. Refer to CHAPTERS 7 and 11. If you cannot reprogram the adapter, the problem may be due to the first two items above. Return the adapter for servicing.
EMPTY	The Battery Adapter is recognized but there is not a battery installed. Press the appropriate Display Key to see if the battery parameters are correct for the battery you wish to service.
INV CODE	Selected battery parameter setting is out of range. Correct the setting or reset the parameters to Factory C-Code with the Utility menu. Refer to CHAPTER 8 — UTILITIES.
INV TYPE	Invalid Battery Adapter. The Battery Adapter is not compatible with the C4000.
NULL CODE	The Battery Adapter has not yet been programmed. Enter the correct battery C-Code.

CHAPTER 7

PROGRAMMING BATTERY ADAPTERS

1. C-Code Definition

The C-Code is a set of battery parameters stored in the Battery Adapter. When the Battery Adapter is installed, the analyzer reads the C-Code and configures the Station to the appropriate battery parameters. The C-Codes can be altered by the user. There are two C-Codes stored in the adapter: the **Factory C-Code** and the **User C-Code.**

Factory C-Code

The Factory C-Code is programmed to a certain battery type and is non-erasable. The C-Code number and battery type are indicated on the label attached to the Battery Adapter. To read the label, the Battery Adapter must be removed.

A Universal Battery Adapter, such as the Smart Cable, uses a NULL CODE as the Factory C-Code. To activate this Battery Adapter, a C-Code specific to the battery must be entered.

User C-Code

The User C-Code is entered by the user. By doing so, the User C-Code becomes the dominant code and the Factory C-Code moves to the background. The Factory C-Code can be reinstated with the Utility menu (refer to CHAPTER 8 — UTILITIES).

Note The Battery Adapters can be reprogrammed up to 100,000 times. The code is retained when the analyzer is off or the Battery Adapter removed.

2. C-Code Structure

The C-Code is made up of two parts: **Basic C-Code** and **Extended C-Code.**

Basic C-Code

The Basic C-Code contains the fundamental battery parameters consisting of:

Battery type (NiCd, NiMH and SLA)

Number of cells

Battery rating in mAh.

Extended C-Code

Additional battery parameters are included in the Extended C-Code. The Extended C-Code varies with each battery type and may consist of:

- Charge & Discharge C-Rates
- Trickle-charge current
- Recondition Discharge current
- Capacity Offset
- Temperature Sensor (optional)
- Negative Slope
- End-of-discharge voltage threshold
- End-of-recondition voltage threshold
- Charge method.

The Extended C-Code is not shown if all parameters are at the default values. If any of these parameters are modified, the complete C-Code (Basic C-Code and Extended C-Code) are shown. For more information, refer to CHAPTER 11 — C-CODE TABLES.

3. Quick View of Battery Parameters

The parameters programmed into the Battery Adapter can be viewed by pressing the Display Key when in "EMPTY" status. This feature allows you to verify the parameters before connecting the battery.

Multi-frame display

The parameters are contained in several frames, starting with the basic information in the first frame, followed by more detailed definitions in the subsequent frames.

To step through the frames, press the appropriate Display Key several times. Eventually you will loop around to the beginning.

To revert to the Global Display, insert a battery or press any other Display Key.

While a battery is being serviced, its parameters can be viewed by selecting VIEW BATTERY PARAMETERS in the Menu (refer to "4. Menu Tree" in this chapter).

Modifying the battery parameters, setting the time and print format, and other operations are performed within the menu mode (refer to "5. Menu Functions" in this chapter).

4. Menu Tree

The Menu Tree is like a road map. It provides an overview of the available menu options and indicates how to get there.

The main menu options are:

- VIEW BATTERY PARAMETERS?
- MODIFY BATTERY CODE?
- DATE/TIME?
- PRINTER FORMATS?
- UTILITIES?

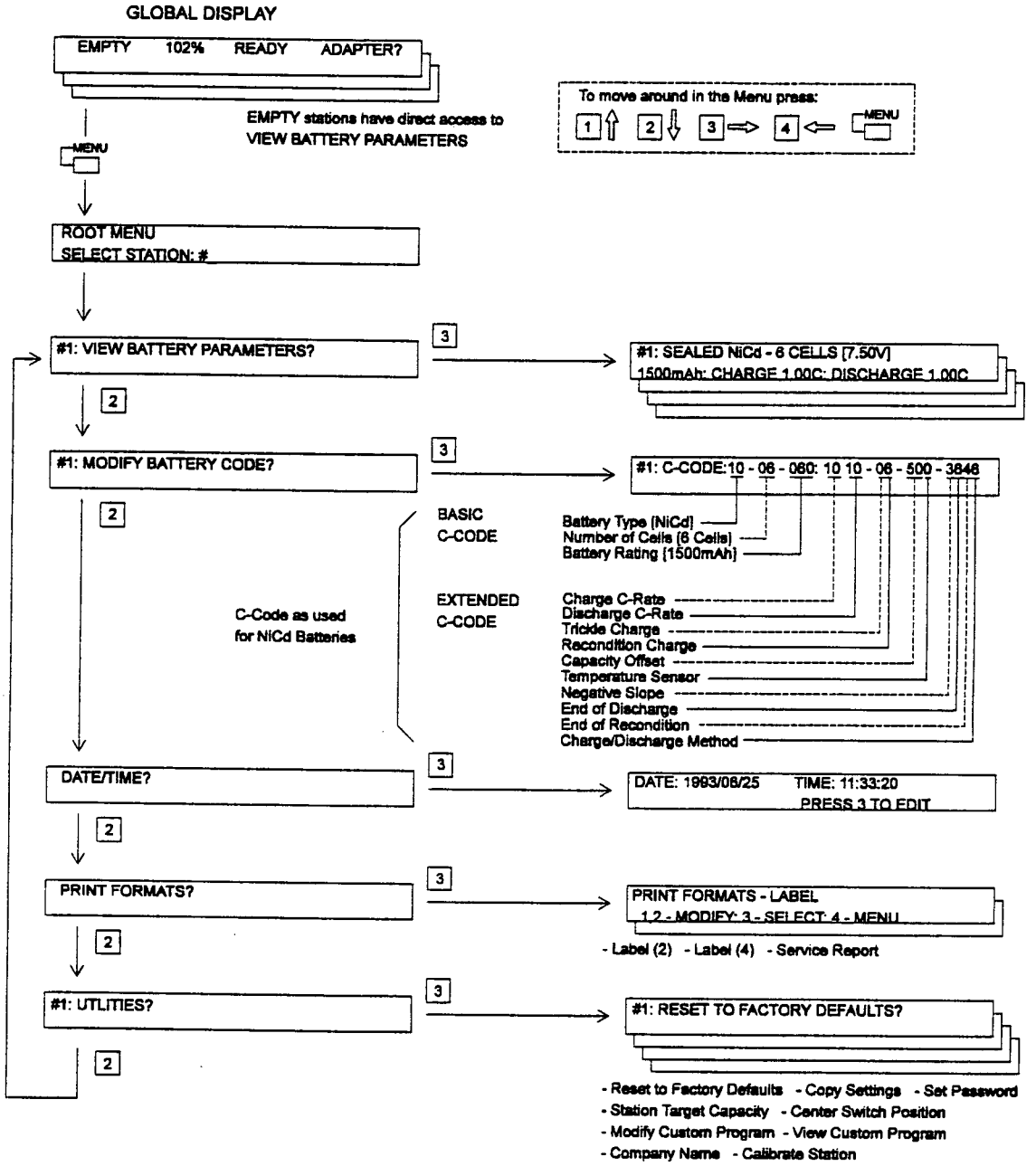

GLOBAL DISPLAY
EMPTY 102% READY ADAPTER?
EMPTY stations have direct access to VIEW BATTERY PARAMETERS
To move around in the Menu press:
1 2 3 4 MENU
MENU
ROOT MENU
SELECT STATION: #
#1: VIEW BATTERY PARAMETERS?
#1: SEALED NiCd - 6 CELLS [7.50V]
1500mAh: CHARGE 1.00C: DISCHARGE 1.00C
#1: MODIFY BATTERY CODE?
#1: C-CODE:10 - 06 - 060: 10 10 - 06 - 500 - 3848
BASIC C-CODE
Battery Type [NiCd]
Number of Cells [6 Cells]
Battery Rating [1500mAh]
EXTENDED C-CODE
Charge C-Rate
Discharge C-Rate
Trickle Charge
Recondition Charge
Capacity Offset
Temperature Sensor
Negative Slope
End of Discharge
End of Recondition
Charge/Discharge Method
C-Code as used for NiCd Batteries
DATE/TIME?
DATE: 1993/08/25 TIME: 11:33:20
PRESS 3 TO EDIT
PRINT FORMATS?
PRINT FORMATS - LABEL
1,2 - MODIFY; 3 - SELECT; 4 - MENU
- Label (2) - Label (4) - Service Report
#1: UTLITIES?
#1: RESET TO FACTORY DEFAULTS?
- Reset to Factory Defaults - Copy Settings - Set Password
- Station Target Capacity - Center Switch Position
- Modify Custom Program - View Custom Program
- Company Name - Calibrate Station

Figure 7.1

5. Menu Functions

The menu is used to modify the existing battery parameters (C-Code), set Date/Time and Print Formats (Option-P only), or use any of the specific functions in the Utilities.

Entering menu mode from Global Display

Press the Menu Key and select the Station with the Battery Adapter you wish to modify. While in menu, the Menu LED is on.

The four Display Keys are now used to select and enter the menu options. To exit the menu mode without a change, press the Menu Key again.

Menu Navigation

Keys 1 and 2 move you through the menu options (up and down);
Key 3 enters the menu option;
Key 4 lets you step back to the previous menu option;
Menu Key lets you enter or exit the menu mode.

Note

- While in menu mode, the batteries being processed are not affected; they continue with the program as usual.
- A Battery Adapter can only be reprogrammed if it is EMPTY.
- Menu mode will time out in 5 minutes if left unattended.

View Battery Parameters

This menu option lets you view the parameters of the Battery Adapter while the battery is being serviced.

The parameters are contained in several frames, starting with the basic information in the first frame, followed by more detailed definitions in the subsequent frames. Keys 1 and 2 let you scroll through the available menu options.

Note To quick-view the battery parameters without going through menu mode, refer to "3. Quick View of Battery Parameters" in this chapter.

To view the battery parameters, follow these steps:

- Start from the Global Display
- Press the Menu Key
- Press the Display Key at the appropriate station
- Press Key 3.

The Display reads:

Frame 1: without Auto-scale

```
#1: SEALED NiCd
   6 CELLS (7.5V); 1500mAh
```

Sample setting only

Explanation

#1	=	Selected Station
SEALED NiCd	=	Battery type
6 CELLS (7.5V)	=	Number of cells and battery voltage
1500mAh	=	Battery rating

Frame 1: with Auto-scale

```
#1: SEALED NiCd; AUTO-SCALE
   6 CELLS (7.5V); 4000mAh
```

Note Auto-scale is active if the Extended C-Code is set to the default setting. In this case, if the battery rating entered is higher than 2000mAh, auto-scale limits the maximum charge and discharge current to 2000mA by selecting a lower C-Rate. Auto-Scale is not active if you set your own charge and discharge C-Rates.

Example A 4000mAh battery is scaled to a charge and discharge current of 2000mA at a C-Rate of 0.5C. Charge and discharge times are double.

Frame 2:

```
#1: CH 0.5C (2000mAh); DCH 0.5C (2000mAh)
    TRICKLE CH 8%; RECON DCH 12%
```

Explanation

CH 0.5C (2000mAh)	= Charge C-Rate, current is 2000mA
DCH 0.5C (2000mAh)	= Discharge C-Rate, current is 2000mA
TRICKLE CH 8%	= Trickle charge current
RECON DCH 12%	= Recondition discharge current

Frame 3:

```
#1: CAPACITY OFFSET +0%; TEMP N/A
    SLOPE -32mV/CELL
```

Explanation

CAPACITY OFFSET	= Corrects capacity measurement when applying different discharge rates (see battery specifications)
TEMP N/A	= Optional battery temperature sensor
NEGATIVE SLOPE (-32mA/CELL)	= Battery voltage drop at full-charge state

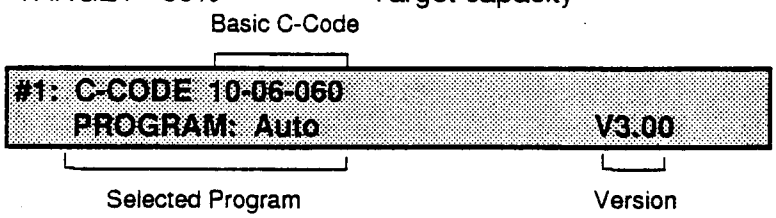
Frame 4:

```
#1: DCH TO 1.00V; RECON TO 0.40V
    REV LOAD 6%; TARGET 80%
```

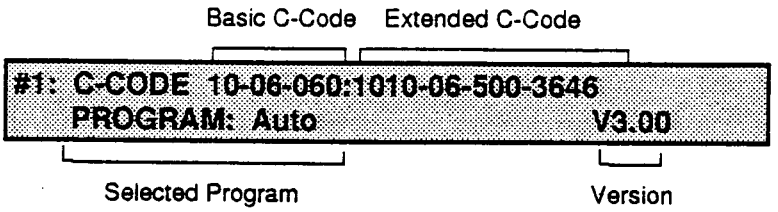
Explanation

DCH TO 1.00V	= End-of-discharge voltage = threshold
RECON TO 0.4V	= End-of-recondition voltage = threshold
REV LOAD 6%	Size of interspersing discharge pulses during charge
TARGET 80%	Target capacity

Frame 5: without Extended C-Code



Frame 6: with Extended C-Code



Note The Extended C-Code is only shown if different than the default setting.

Modify Battery Code

Modifying the battery parameters (C-Code) is done with the MODIFY BATTERY CODE menu option.

To familiarize yourself with modifying these parameters, the following two examples will show you how to enter the MODIFY BATTERY CODE menu option and change certain parameters. In Example 1, only the Basic C-Code is modified. Example 2 changes the Basic and Extended C-Code.

To begin:

- Start from the Global Display
- Press the Menu Key
- Press the Display Key at the appropriate station
- Press Key 2 to scroll to MODIFY BATTERY CODE
- Press Key 3 to enter.

Once you have entered into this option, Keys 1 or 2 modify the C-Code, Key 3 accepts and advances to the next setting, Key 4 steps back one setting, and the Menu Key exits without change. As you step through the C-Code numbers, the second line of the LCD describes the battery parameters.

Note Stepping through the C-Code with Key 3 or 4 does not change the code; it only views the battery parameter for each set segment. If a setting is modified by mistake, press the Menu Key to exit without change.

Example 1 Change battery rating from current setting of :

- NiCd of 6 cells (7.5V) 1500mAh; C-Code **10-06-060** to
- NiCd of 6 cells (7.5V) 1200mAh; C-Code **10-06-048.**

Cursor position at start

```
#1: C-CODE: 10-06-060
    BATTERY TYPE:          1 OR 2 TO MODIFY
```

Press 3	to go to the NUMBER OF CELLS
Press 3	to go to BATTERY RATING
Press 1 or 2	to modify BATTERY RATING
Press 3	to move to 2nd digit

Cursor position

```
#1: C-CODE: 10-06-060
    BATTERY RATING: 1500mAh    (250 step)
                                    |
                                mAh steps
```

When in BATTERY RATING, the mAh step size is indicated on the lower right of the LCD. The 1st digit of the C-Code segment advances in 2500mAh steps, the 2nd in 250mAh and the 3rd in 25mAh steps.

Press 2 twice	to change BATTERY RATING from 060 to 048
Press 3	to move to 3rd digit
Press 2 twice	to change BATTERY RATING 040 to 048
Press 3	to save new C-Code

After the Basic C-Code parameters have been selected, the following options are offered:

```
#1: C-CODE: 10-06-048
    PRESS 1,2 TO CONTINUE; 3-SAVE; 4-PREV
```

Pressing Key 3 saves the selected setting. A gong signal indicates that the new C-Code has been accepted and is stored in the Battery Adapter. To verify the new setting, press Key 1 to scroll to the VIEW BATTERY PARAMETERS menu option, and then press Key 3. The new rating should now be 1200mAh.

Example 2 Change battery type, cell count, current rating and C-Rate to:

- NiCd of 6 cells (7.5V) 4000mAh, C-Rate of 0.33; C-Code **11-06-160:3333-06-500-3646.**

Repeat the keystroke procedure listed at the beginning of this section to enter the MODIFY BATTERY CODE menu option. Now, modify the Basic C-Code to **11-06-160.**

Note Battery type 11 is chosen to allow selecting the C-Rate of 0.33C. If 0.5C is used, for example, the battery type can remain 10 (refer to CHAPTER 11, "1. Battery Type").

At this point the parameters for the Basic C-Code are completed and the display should read as follows:

```
#1: C-CODE: 11-06-160
    PRESS 1,2 TO CONTINUE; 3-SAVE; 4-PREV
```

Now, change the C-Rate from the default value of 1C to 0.33C. The C-Rate is part of the Extended C-Code.

Press 1 or 2 to CONTINUE (entering Extended C-Code)
Press 1 or 2 to modify CH & DCH C-RATE (charge & discharge C-Rate)
Press 1 or 2 then 3 to modify charge/discharge C-Rate from 1010 to 3333

Repeat this procedure until all changes are made and the display reads:

```
#1: C-CODE: 11-06-160:3333-06-500-3646
    3 SAVE; 4 PREV; MENU KEY - EXIT
```

Key 3 saves all changes; Key 4 moves back to a previous setting; the Menu Key exits without changes.

Note. Default settings of the Extended C-Code are marked with (*) on identification message.

CHAPTER 8

UTILITIES

Introduction

The UTILITIES menu option includes the following options:

- RESET TO FACTORY DEFAULT
- COPY SETTINGS
- SET PASSWORD
- STATION TARGET CAPACITY
- CENTER SWITCH POSITION*
- MODIFY CUSTOM PROGRAM*
- VIEW CUSTOM PROGRAM*
- COMPANY NAME
- CALIBRATE STATION

Note Refer to CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS for details on using the menu mode and accessing different options.

1. Reset to Factory Default

RESET TO FACTORY DEFAULT restores the Battery Adapter to the Factory C-Code. By doing so, the User C-Code is erased. For information on Factory C-Code and User C-Code, refer to CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS.

Press the Menu Key and select a Station (Station 1 is used through all examples). Scroll with Key 1 or 2 and go to UTILITIES in the menu. Press Key 3 to enter. Press Key 3 again to enter RESET TO FACTORY DEFAULT. The display reads:

```
#1: RESETTING TO FACTORY DEFAULTS
   3 RE-INSTALL 4 PREV; MENU KEY - EXIT
```

Press Key 3 to reset to Factory Default. The gong tone indicates that the Factory C-Code has been reinstated.

* Refer to CHAPTER 9 - CUSTOM PROGRAMS.

2. Copy Settings

A Battery Adapter parameter's can be copied to another Battery Adapter with COPY SETTINGS.

To copy settings

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to COPY SETTINGS and enter. The display reads:

```
#1 COPY SETTINGS
:  COPY FROM STATION 1 TO STATION: #
```

Select the appropriate Station. The gong tone indicates that the C-Code has been copied to the desired Station.

3. Set Password

A password may be entered to protect the Battery Adapter from unauthorized changes. The password is retained in the Battery Adapter.

If a Battery Adapter has been protected, the correct password must be entered before making any of the following changes:

- Modifying C-Code
- Resetting to Factory C-Code
- Setting Station Target Capacity
- Copy Settings
- Set Password
- Calibrate Station.

To enter Password

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to SET PASSWORD and enter. The display reads:

```
#1: EDIT PASSWORD: 000
```

Press Key 1 or 2 to enter the first digit, then press Key 3 to advance to the second digit. After all three digits have been edited, press Key 3. The gong tone verifies that the password has been accepted.

To change Password

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to SET PASSWORD and enter. If the Battery Adapter in question is protected by a password, the display reads:

```
PASSWORD FOR STATION #1? 000
```

Enter the correct password to gain access and press Key 3. The display reads:

```
EDIT PASSWORD: XXX
```

Enter the revised password and press Key 3. A gong tone indicates that the new password has been accepted.

To remove Password

Select SET PASSWORD from UTILITIES; enter current password when prompted; at "EDIT PASSWORD" enter 000.

Caution: Remember the Password If the password is unknown, the Battery Adapter is frozen. If this occurs, please contact CADEX ELECTRONICS INC.

4. Station Target Capacity

A Target Capacity for each Station can be set independently using any number from 1% to 199%. This Station Target Capacity is retained in the Battery Adapter and is applied instead of the Global Target Capacity set by the Target Selector Switch.

To enter a Station Target Capacity

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to STATION TARGET CAPACITY and enter. The LCD reads:

```
#1: STATION TARGET CAPACITY: 000%
    GLOBAL SETTING USED
```

The global setting of the Target Selector Switch is currently in effect. Press Key 1 or 2 to alter setting, press Key 3 to enter.

To restore Global Target Capacity

Repeat above steps to enter STATION TARGET CAPACITY. On the "STATION TARGET CAPACITY:" prompt, enter 000.

5. Company Name (Option-P only)

This option allows you to enter your company name (or phone number). The information is printed on all labels and service reports.

To enter Company Name

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to COMPANY NAME and enter. The display reads:

```
COMPANY NAME ***CADEX INC  ***
1,2 - MODIFY CHARACTER; 3-NEXT; 4-PREV
```

Keys 1 and 2 now scroll through 0 to 9 and A to Z. Press Key 3 to enter the desired numbers and/or letters and advance to the next digit; Key 4 lets you step back for corrections.

The sequence is as follows:
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -(dash), . (period), [ ] (space), A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The default setting is "CADEX INC".

Note The space for the Company Name is limited to 15 digits.

6. Calibrate Station

Station calibration compensates for capacity losses introduced by battery cables, electrical connections, and the analyzer's internal sensing circuit.

Applying this menu option prevents the analyzer from ending the discharge cycle early and displaying low-capacity readings.

Calibration is mandatory if

- Battery pack has 4, 3 or 2 cells and discharge current is 1000 mA or higher; or
- Battery consists of a single cell and discharge current is 700mAh or higher.

To calibrate

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to CALIBRATE STATION and enter. The LCD reads:

```
#1: STATION CALIBRATION
SHORT THE LEADS
```

Important Remove the battery and assure the lead ends of the Battery Adapter make good contact during the procedure.

Note If a battery holder is being used, short the terminals with a low resistance shunt. A 10-guage wire (2.5 mm) is recommended.

Press the Display Key for the Station to start calibration. While calibrating, the LCD read:

```
#1: STATION CALIBRATION
CALIBRATION IN PROGRESS
```

At the end of calibration, a triple beep is heard and the LCD reads:

```
#1: STATION CALIBRATION
DONE! DISCONNECT LEADS
```

If the leads had opened during the test, the LCD reads: "CALIBRATION ERROR, PRESS ANY KEY". The calibration must be repeated.

Verifying calibration (battery holder only)

After calibration, remove the shunt and insert the battery. When in discharge, measure the battery voltage with a voltmeter (DVM type). If the battery is made of a number of cells, calculate the average cell voltage by dividing the measured voltage by the number of cells. Compare this reading with the average cell voltage displayed on the LCD. If the readings differ by more than 60mV, repeat the calibration.

Calibration notes

Calibration is only applicable to discharge.

It is absolutely necessary that the contact resistance between the battery terminals is as low as possible when calibrating. Alligator clips or light gauge jumper wires for connection is not recommended.

There is no shock hazard when touching the bare wires coming off the Battery Adapter, nor is there any hazard in shorting the Battery Adapter leads.

It is recommended to re-calibrate if the Battery Adapter is moved form one Station to another.

Caution

- **Do not short** the battery at any time.
- **Do not short** the Battery Adapter leads to the side plates of the C4000.

Limitations on single cells

Maximum 1000mA for single cell

The maximum discharge current of a single cell is limited to 1000mA, even with calibration. The current may have to be set lower if cable length or contact resistance cause a problem. Possible problems are:

Fail 62

If the discharge current is set too high, FAIL 62 appears. The battery cannot supply the requested discharge current. If this occurs, check the battery or lower the discharge current.

Fail 64

If the Reverse Load current of a battery cannot be met, FAIL 64 appears. If this occurs, check the battery or lower the Reverse Load current.

CHAPTER 9

CUSTOM PROGRAMS

Introduction

The Custom Program enables you to choose any desired sequence of charge, discharge, recondition or trickle charge. Rest periods, repeats and stop can also be added. This program allows long-term battery reliability tests, a self-discharge check, the priming of new batteries and more.

1. Setting up Custom Program

The Custom Program can be assigned to any or all Stations.

Modify Custom Program

The UTILITIES menu option allows you to enter and modify the Custom Program. The programming is similar to entering a C-Code. For an explanation on entering the C-Code, refer to CHAPTER 7, "5. Menu Functions".

Note Refer to CHAPTER 7, "4. Menu Tree" as a guide for using the menu mode and accessing different options.

To modify the Custom Program, press Menu and select a Station (we have selected Station 1). Scroll to UTILITIES using Key 1 or 2, press Key 3 to enter, scroll to MODIFY CUSTOM PROGRAM and enter. The display reads:

↓ Cursor position at start

```
CUSTOM PROGRAM: 0000:0000:0000:0000:00
  PHASE 1:                  1 OR 2 TO MODIFY;
```

To familiarize yourself with the Custom-Code function, practice by entering a code that reflects the AUTO program (refer to Figure 9.1 for description of AUTO-program field settings).
The code is: **1020:2120:3000:2100:21**.

To continue to the next field setting, press Key 3; to step back, press Key 4; to apply changes to a Phase, scroll the number by pressing Key 1 or 2, then press Key 3 to accept and advance; to exit without changes, press the Menu Key.

Instruction codes for the AUTO program

Figure 9.1 describes the code used to perform the AUTO program. Please note that AUTO can conveniently be set with the Program Selector Switch.

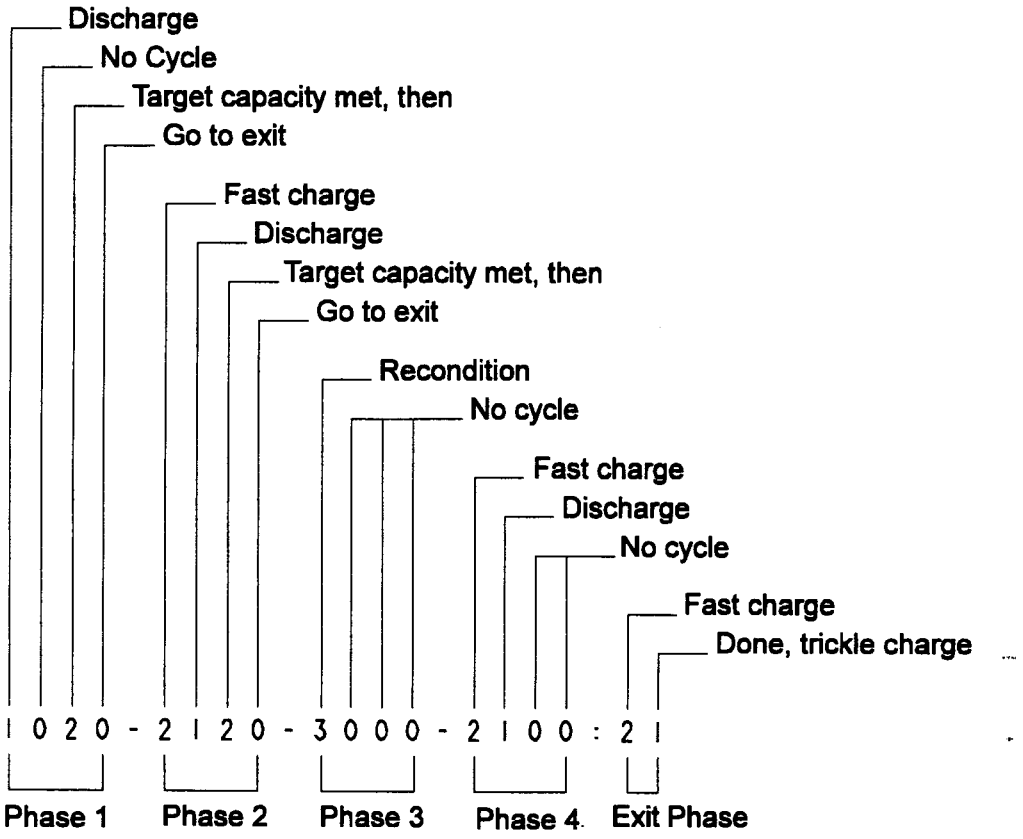


Figure 9.1

Center Switch Position

The Custom Program shares the CHARGE setting on the Program Selector Switch. With the UTILITIES Menu, the center switch positions of the program selectors can be set to either CHARGE (default setting) or CUSTOM. Any or all program switches may be changed.

Limitation Only one Custom Program configuration can be stored at any time within the analyzer. The program may be assigned to any or all Stations. It is not possible to assign various Custom Programs to different Stations.

To change the Center Switch Position

Press Menu, select Station, scroll (Key 1 or 2) to UTILITIES, enter, scroll to CENTER SWITCH POSITION and enter. The display reads:

```
#1: CENTER POSITION = CHARGE
1,2 - MODIFY; 3-SAVE; 4-MENU
```

Press Key 1 (or 2) to alter setting from CHARGE to CUSTOM. Press Key 3 to save.

The Center Switch Position on the selected Station has now been changed from CHARGE to CUSTOM.

To verify, move the appropriate Program Selector Switch to the center position. Press the appropriate Display Key while in EMPTY. Press the same key several times until the display reads:

```
#1: C-CODE: 10-06-048
    PROGRAM: Custom          V3.00
```

Example only

Changing the Program Selector Switch setting will indicate the selected program on the display.

With OPTION-P If your unit is equipped with OPTION-P, the information will be retained when the power is turned off.

Without OPTION-P If your unit is not equipped with OPTION-P, the code information will be lost when the C4000 is turned off.

If the unit is turned off with the Station on EMPTY (no test battery), the Custom Program Code resets to CHARGE.

If the unit is turned off with a battery in service, the Custom Code reverts to a HOLD condition. While on hold, neither charge nor discharge is applied to the test battery.

OPTION-P with dead back-up battery — If the back-up battery has been removed or is no longer functional, OPTION-P cannot retain the Custom Program Code. In this case the function will be as per "Without OPTION-P".

2. Typical Applications

Discharge only for NiCd battery — Manufacturers of NiCd batteries claim that it is best to store a NiCd in a discharged state. Airfreight companies prefer to transport batteries in discharged rather than charged state.

Program — Discharge to 1V/cell, then stop (no trickle charge).

Custom-Code — **1000-0000-0000-0000:00**

Phase 1 — [1000] 1=discharge; 0=no cycle; 00=skip.

Phase 2-4 — 0000-0000-0000=skip to Exit Phase.

Exit Phase — [00] 0=no cycle; 0=done, no trickle charge.

Deep-discharge NiCd battery — When storing NiCd batteries for a prolonged time, it is best to apply a discharge followed by a secondary slow discharge (recondition).

Program — Discharge to 1V/cell, followed by recondition, then stop (no trickle charge).

Custom-Code — **1300-0000-0000-0000:00**

Phase 1 — [1300] 1=discharge; 3=recondition; 00=skip TG.

Phase 2-4 — 0000=0000-0000=skip to Exit Phase.

Exit Phase — [00] 0=no cycle; 0=done, no trickle charge.

Long-term battery reliability — A manufacturer must verify the performance of a battery by cycling it at a given charge and discharge rate until its capacity drops below the user-selectable Target Capacity. The number of cycles are counted and displayed (refer to "1. Setting up Custom Program" in this chapter).

Program Charge/discharge the battery until the derived capacity drops to below the set target setting.

Custom-Code **2121-0000-0000-0000:00**

Phase 1 [2121] 2=charge; 1=discharge; 21=if target capacity is met, go-to Phase 1 (repeat as long as Target Capacity is met; if it is not met, go-to the next Phase).

Phase 2-4 0000=0000-0000=skip to Exit Phase.

Exit Phase [00] 0=no cycle; 0=done, no trickle charge.

Prime a new or stored battery

A new battery, or one that has been in prolonged storage, will often not accept a fast-charge. Manufacturers recommend a 16-to-24-hour trickle charge prior to use. A prolonged trickle charge is often not sufficient to prepare the battery for field use. The battery should also be cycled (primed). Please note that not all batteries behave the same.

Program First, an experimental fast-charge is applied to evaluate whether the battery will accept charge. If the discharge that follows produces a capacity of more than 5%, the battery is assumed fit for fast-charge and a number of charge-discharge cycles (prime) are applied until the capacity reaches the maximum reading.

If the initial fast-charge produces capacity readings of 5% or less, the battery is first trickle charged (Phase 4) for approximately 16 hours, then primed (Phase 2).

Custom-Code **2134-2140-0012-4112:21**

Phase 1 [2134] 2=fast-charge; 1=discharge; 34=if the capacity is less than 5% (not ready to accept fast-charge), go-to phase 4 for trickle-charge, or else go-to Phase 2.

Phase 2 [2140] 2=fast-charge; 1=discharge; 40=if the capacity improvements (in comparison to the previous reading) is less then 5%, go-to exit (it is assumed that the battery has reached maximum capacity), or else go-to Phase 3.

Phase 3 [0012] 00=skip CC; 12=proceed back to Phase 2 to repeat.

Phase 4 [4112] 4=trickle charge until fully charged (battery was unable to generate a capacity of 5% with fast-charge); 1=discharge; 12=proceed back to phase 2.

Exit Phase [09] 0=no cycle; 1=done, trickle charge.

Self-discharge test

After the battery has aged or has performed over 1000 charge-discharge cycles, the self-discharge of the rechargeable battery increases. Typically, a NiCd battery loses 10% of the original capacity over a 24-hour storage period. At higher storage temperatures, the self-discharge is higher.

When performing the self-discharge test, we compare the battery capacity reading that was obtained right after charge and compare it with the reading that is taken after the user-selected rest period. A practical rest period may be 12 or 24 hours.

Program The battery is first charged, then discharged to measure the full capacity. The battery is then recharged and put on a rest period. After that time, the battery is discharged to measure the remaining capacity. The comparison between the second last reading (Full Capacity) and the last reading (capacity after rest) reveals how much capacity was lost due to self-discharge.

Custom-Code **2100-2066-1000-0000:21**

Phase 1 [2100] 2=fast-charge; 1=discharge (to obtain capacity with full charge); 00=skip.

Phase 2 [2066] 2=fast-charge; 66=24h rest cycle (user-defined).

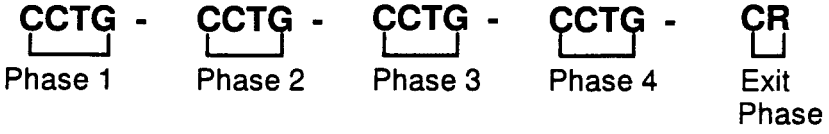
Phase 3 [1200] 1=discharge (to obtain capacity after 24h rest); 2=fast-charge; 00=skip.

Phase 4 0000=skip.

Exit Phase [21] 2=fast charge; 1=done, trickle charge.

3. Code Definition

The Custom Program is divided into four Phases and one Exit Phase. Each Phase can be programmed independently. The complete Custom Code is as follows:



Each Phase consists of:
C = Cycle (two identical cycles per Phase)
T = Test
G = Go-To

The Exit Phase consists of:
C = Exit Cycle (identical to "C" in other Phases)
R = Ready

We are now examining the function of a Phase consisting of "Cycle 1 and Cycle 2", "Test" and "Go-To".

Cycle 1 and Cycle 2

Cycle 1 and Cycle 2 at the beginning of each Phase perform the actual service. To skip and go to the next Cycle, enter 0. To apply a service, enter a number as per Table 9.1.

	CYCLE 1	CYCLE 2
0	No cycle	No cycle
1	Discharge	Discharge
2	Fast-charge	Fast-charge
3	Recondition	Recondition
4	Trickle charge	Trickle charge
5-9	Invalid Cycle	Invalid Cycle

Table 9.1

Example By entering "2100" (charge-discharge-skip-skip), the battery is first fully charged, then discharged to the end-of-discharge threshold. "00" skips Test and Go-To and advances to Phase 2.

Test and Go-To

The third and fourth digits of a Phase are assigned to "Test" and "Go-To".

- Test provides further instructions after Cycles 1 and 2 have been completed.
- Go-To executes these instructions.

Table 9.2 illustrates the options of Test and Go-To.

	(T) Test		(G) Go-To
0	Skip (T) Test	0	Go-to the next Phase
1	Proceed unconditionally	0	Go-to Exit Phase
		1	Go-to Phase 1
		2	Go-to Phase 2
		3	Go-to Phase 3
		4	Go-to Phase 4
2	Target Capacity met	0	Go-to Exit Phase
		1	Go-to Phase 1
		2	Go-to Phase 2
		3	Go-to Phase 3
		4	Go-to Phase 4
3	Capacity less than 5%	0	Go-to Exit Phase
		1	Go-to Phase 1
		2	Go-to Phase 2
		3	Go-to Phase 3
		4	Go-to Phase 4
4	Capacity not improved by 5%	0	Go-to Exit Phase
		1	Go-to Phase 1
		2	Go-to Phase 2
		3	Go-to Phase 3
		4	Go-to Phase 4
5	Do Phase N times	0	Go-to the next Phase
		1	Do Phase 1 time
		2	Do Phase 2 times
		3	Do Phase 3 times
		4	Do Phase 4 times
		5	Do Phase 5 times
		6	Do Phase 6 times
		7	Do Phase 7 times
		8	Do Phase 8 times
		9	Do Phase 9 times
6	Rest Cycle	0	15 minutes
		1	30 minutes
		2	1 hour
		3	3 hours
		4	6 hours
		5	12 hours
		6	1 day (24h)
		7	2 days (48h)
		8	7 days
		9	14 days

Table 9.2

Explanation of Test

0 Advances to the next Phase.

1 Provides an unconditional choice to either exit or advance to any of the 4 available Phases, regardless of the Target Capacity setting, capacity gains or other criteria.

2 "Target Capacity met" lets you take a different route if the required Target Capacity is met. You many want to go-to exit, for example, and complete the program.

3 "Capacity less than 5%" lets you repeat Cycles 1 and 2 a maximum of three times in hope that the battery will start accepting a proper charge. A new battery, or one that has been in storage for a long time, may be subject to very low capacity readings when first serviced.

4 "Capacity not improved by 5%" indicates that the battery has reached its full-capacity potential and further cycling will be of no benefit. In this case, you many want to go-to exit and complete the program.

5 "Do Phase N Times" lets you repeat a procedure up to 10 times.

6 "Rest Cycles" lets you add rest periods to cool off the battery, for example. Another application is to perform self-discharge tests on a battery.

Explanation of Go-To

After the Test command is completed, Go-to takes the next step and executes the instructions.

Failed conditional test

If a conditional test failed, the Go-To is not executed and the program goes directly to the next Phase.

Example Conditional tests are "Target Capacity met", "Capacity less than 5%" and "Capacity not improved to 5%".

Exit Phase

The Custom Program concludes with the Exit Phase. This Phase consists of Cycle and Ready.

Cycle is identical to the Cycle 1 and 2 in the Phases.

Ready completes the program. You have a choice of trickle charge or no trickle charge while in ready mode.

Table 9.3 illustrates the options of Cycle and Ready.

	Cycle	Ready
0	No cycle	Done, no trickle charge
1	Discharge	Done, trickle charge, standby active
2	Fast-charge	Invalid Standby Code
3	Recondition	Invalid Standby Code
4	Trickle charge	Invalid Standby Code
5-9	Invalid Cycle	Invalid Standby Code

Table 9.3

4. Program Variations

The Custom Program offers a large variety of cycle combinations, loops and detours.

To safeguard against entry of illegal codes that could damage the battery, the C4000 firmware checks for any redundancies to allow executing the program in an orderly fashion. In the following paragraph we study the "what-would-happen" syndromes if invalid codes are entered.

Identical cycles

If two or more cycles with the same function are entered consecutively, the first cycle is executed and the following cycles are skipped.

Example The Custom Pogram will not apply two successive charge cycles.

Unsuitable cycle

Any cycles unsuitable for a specific battery chemistry are skipped.

Example No recondition is applied to an SLA battery; a deep discharge could harm the battery.

Faulty battery

If a battery fails, the program is terminated.

Example A battery with shorted cells unable to reach the required window voltage cannot continue to the next Phase.

Cycles 1 and 2 count limit

After Cycles 1 and 2 are performed, the battery's capacity may be less than 5%. The "Capacity less than 5 %" Test command can be used, and will allow a maximum of three repeats of Cycles 1 and 2. If 5% cannot be reached by then, the program advances to the next Phase.

Recondition

Recondition can only be applied after a discharge cycle.

CHAPTER 10

OPTIONS

Introduction

Your C4000 is equipped with OPTION-P if the model number reads "CDxx-x**P**". The firmware with OPTION-P is labelled "V3.xx**P**".

Option-P includes:

- Data Retention
- Printer interface (RS-232 Port #2)
- Computer interface (RS-232 Port #1).

1. Data Retention

Power failure

The Data Retention holds the battery test results in case of power failure. When the power is restored, the C4000 resumes where it had left off.

Note To retain the test results, the batteries must remain engaged when power is turned on.

The Data Retention maintains the following setting when the unit is turned off:

- Date/Time
- Print format
- Custom Program
- Company Name.

2. Date/Time

The Date/Time information maintains the year, month, day, hour, minute and seconds. This information appears on all print reports and is transferred to the computer, if interfaced.

Back-up battery

The date, time and other information is backed-up with a lithium battery. The life expectancy of the battery is:

- 2 to 3 years if the C4000 is turned OFF
- 10 years if the C4000 is turned ON.

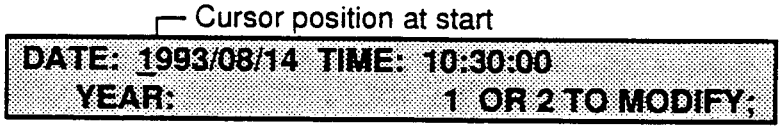
When not in use

If the C4000 is not used for a prolonged time, the battery should be removed from the unit. The battery is accessible by removing the right side plate of the analyzer. Observe static precautions at all times.

When removing the battery, the Date/Time setting will be lost and must be re-entered after the battery is installed. For more information refer to CHAPTER 13 — SERVICE.

To set Date/Time

Press Menu. Select any Station. With Display Key 2 scroll down to "DATE/TIME". Press 3 to enter and press 3 again. The display reads:



To alter the setting, press Key 1 or 2, then press either Key again to change. Key 1 scrolls up, 2 scrolls down. Press 3 to accept the correct setting. Repeat for each digit. Key 4 allows you to step back for corrections.

To accept the new setting, step to the last digit, then press 3. To escape without change at any time, press the Menu Key.

3. Printer Interface

Serial Printer

The "SERIAL PORT 2" of the C4000 allows direct interface with a serial printer. Set the printer to:

- 2400 baud
- 8 Bits
- 1 stop bit
- No parity
- DTR protocol.

Interconnection

Connect the serial cable (included with Option-P) to the C4000 "SERIAL PORT 2" and the serial printer. The printer port is located on the back of the unit.

Parallel Printer

When using a parallel printer, a Serial-to-Parallel converter is required. For best results, use the SP-2 converter offered by CADEX.

Note CADEX cannot guarantee proper function if another Serial-to-Parallel Converter is used.

Interconnection

Connect the cable from the SP-2 converter to Port 2. Connect the centronics cable to SP-2 and Printer. Turn power on. Check the light on SP-2.

Recommendation It is recommended to turn the C4000 and the printer off while interconnecting. Turn the C4000 on first, then the printer or turn both units on simultaneously with a common power switch.

4. Print Formats

The print formats are:

- LABEL (2)
- LABEL (4)
- SERVICE REPORT.

When printing labels, use the custom labels supplied by CADEX ELECTRONICS INC. The Service Report requires standard printer paper.

Label Printing

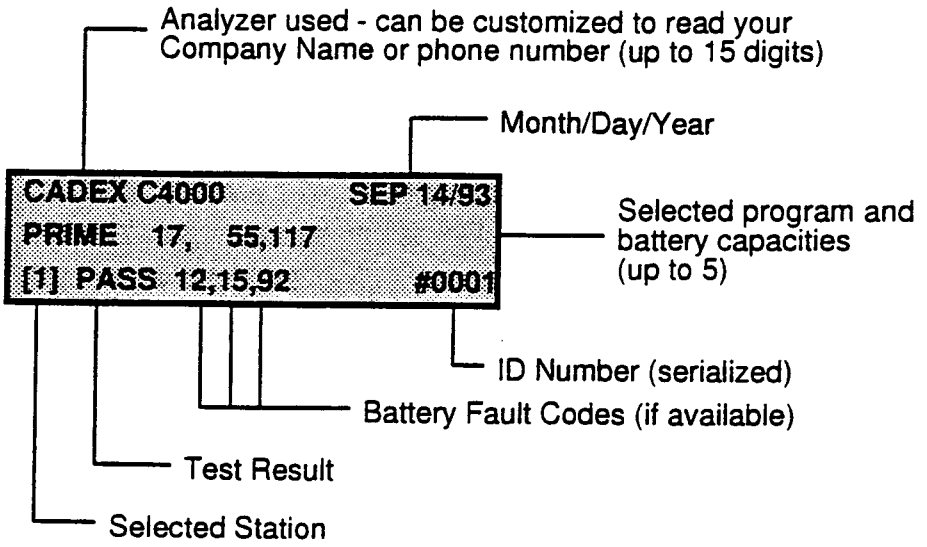
Set up Press Menu, select any Station, scroll (Key 1 or 2) to PRINT FORMATS, and press 3 to enter. Press 1 or 2 to change the present setting. For Label Printing, select either LABEL (2) or LABEL (4).

To print Hold appropriate Display Key down until a beep tone is heard and the display reads: "PRESS KEY AGAIN TO PRINT". Briefly release the key and press again.

Note Before you can print, you must exit the menu mode (press the Menu Key). The printer cannot be activated while in menu mode.

Print in "EMPTY" To print a label after the battery has been removed, repeat as above. The Service Report cannot be printed after the battery has been removed.

Sample of Battery Label



Serialized ID numbers Each time a set of labels are printed, the ID number on the lower right of the label advances by one number. The numbers are consecutive and will reset to 0001 after 9999 is reached. Resetting also occurs by removing the back-up battery.

Use of labels Each print request produces a set of either two or four identical labels. One label is placed on the battery serviced, the duplicates are kept for record keeping.

Hint LABEL (4) allows you more room to remove the labels from the paper.

Installing tractor feed labels When installing the labels, align the paper so that the continuous dashed line falls in between the upper and lower, and the double dashes (--) between the left and right labels.

Printing Service Report

Set up Press Menu, select any Station, scroll (Key 1 or 2) to PRINT FORMATS, press Key 3, then press Key 1 or 2 to select SERVICE REPORT.

To print Hold appropriate Display Key down until a beep tone is heard and the display reads: "PRESS KEY AGAIN TO PRINT". Briefly release the Key and press again.

Alignment of print head The first line is printed at the print-head position. Use standard computer paper.

5. Computer Interface

The "SERIAL PORT 1" of the C4000 allows direct interface with a computer

Interconnection Connect the serial cable (included with Option-P) to the C4000 "SERIAL PORT 1" and the Computer (an adapter may be required). The Port is located on the back of the unit. Set the serial port of the computer to:

- 2400 baud
- 8 Bits
- 1 stop bit
- No parity.

The output of the C4000 is in Delimited ASCII format.

Recommendation It is recommended to turn the C4000 and the computer off while interconnecting.

One-way communication Port 1 can only send data. The C4000 cannot receive instructions from the computer.

6. Event Log

The event log of the C4000 system allows you to record the system's activity as the batteries are being serviced. The event log is formatted as follows:

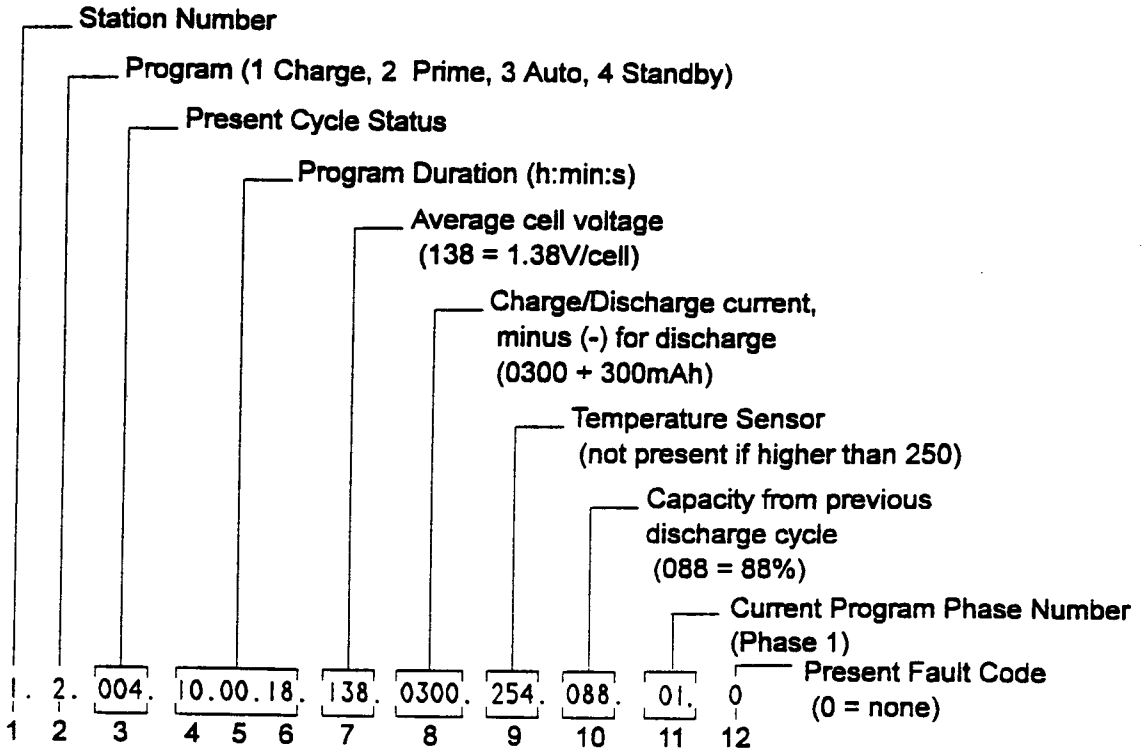


Figure 10.1

Definition of Log Event Fields

Field 1 **Station Number**

Field 2 **Selected Program** Program is either selected or in progress.
1 = CHARGE
2 = PRIME
3 = AUTO
4 = CUSTOM
5 = STANDBY

Field 3 **Cycle Status** The cycle status is composed of a number of 'bit fields'. Each bit field has a number and a condition attached to it.

1 = Discharge cycle
2 = Recondition discharge cycle
4 = Charge
5 = Trickle charge
16 = Battery passed
32 = Program completed
64 = Rest cycle
128 = Program interrupted (due to of battery, over temperature or full load)
256 = Plateau timeout (charge)
512 = Negative slope (charge)

If a certain condition exists, the number presenting that condition becomes the cycle status number. If more than one condition exists, the numbers are added together and the result becomes the cycle status.

Example If the unit has successfully completed a charge program, the fields for: program completed (32), program passed (16) and trickle charge (8) form a set, giving a result of 32 + 16 + 8 = **56**.

Fields 4, 5, 6 **Program Duration** in hours, minutes and system seconds respectively.

Note The program duration may be off by as much as 1 minute due to errors caused when synchronizing with the rest of the system.

Field 7 **Average Cell Voltage** To derive the actual battery voltage, multiply the number of cells by 1.25V (or 1.20V depending on assumed cell voltage) for NiCd or 2.00V for Lead Acid batteries.

Note Some battery manufacturers rate NiCd and NiMH batteries at 1.20V rather than 1.25V per cell. This discrepancy results in a different battery terminal voltage, but does not affect the battery results as the nominal cell voltage of a NiCd is an arbitrary assumed value.

Field 8 **Battery Current** The discharge current is marked with a minus (-) symbol in front of the number; the charge current has no symbol.

Field 9 **Temperature Sensor** Raw temperature input value for that Station.

Field 10 **Battery Capacity** The reading shown represents the previous discharge. The new capacity will be indicated only after the discharge cycle is completed.

Field 11 **Phase Number** The current program phase being performed at that Station. 0 = Exit Phase.

Field 12 **Fault Code** 0 indicates that no fault code is present.

Report Format on Event Log

Once a minute, or anytime a log event occurs, the status of all four Stations is sent. Log events are defined as:

- Program start
- Cycle change (i.e. switching from discharge to charge)
- Program interrupted (temporarily removing the battery)
- Program waiting... (waiting for power, or for the system to cool down).

A sample of event log numbers is shown below.

Station 1 **1, 2, 004, 10,00,18, 138, 0300, 088, 0**
Station 2 **2, 2, 001, 10,00,18, 128, -0306, 021, 0**
Station 3 **3, 2, 004, 2,18,18, 140, 1193, 029, 0**
Station 4 **4, 3, 004, 0,18,19, 120, 0000, 013, 0**

CHAPTER 11

C-CODE TABLES

Introduction

In CHAPTER 7 — PROGRAMMING BATTERY ADAPTERS we familiarized ourselves with the C-Code and its structure. This chapter examines each segment of the C-Code in detail.

Pre-programmed Battery Adapter

If a pre-programmed Battery Adapter is used, the complete C-Code has been entered at the factory and the adapter is ready for service.

Universal Battery Adapter

If a Universal Battery Adapter, such as the Smart "D" Cable, is used, the Basic C-Code must be entered before service. Refer to Chapter 7 — PROGRAMMING BATTERY ADAPTERS.

On the Universal Battery Adapter, all items in the Extended C-Code have been set to a default value. The default values chosen are the settings for most common applications. For specialty applications, the settings in the Extended C-Code can be changed by the user.

Visibility of Extended C-Code

If all items in the Extended C-Code are set to the default values, the Extended C-Code is not shown. By changing a single setting, the Extended C-Code will be shown.

Unique C-Code for different battery types

The configuration of the C-Code differs with each battery type. For example, a NiCd battery uses a different C-Code than an SLA battery. In the latter part of this Chapter, we will look at the Extended C-Code for the NiCd and NiMH first, followed by the Extended C-Code for the SLA battery.

Sequence of C-Code items

The following list is a chapter guide. The C-Code items are listed in the order that they appear in the C4000's C-Code (refer to Figures 11.1, 2 and 3). Some C-Code items of NiCd and NiMH batteries are shared with SLA batteries; other items are exclusive to either NiCd/NiMH or SLA battery chemistry.

	NiCd, NiMH	SLA
Basic C-Code	1. Battery Type	1. Battery Type
	2. Number of cells	2. Number of Cells
	3. Battery Rating	3. Battery Rating
Extended C-Code	4. C-Rate, Charge	4. C-Rate, Charge
	4. C-Rate, Discharge	4. C-Rate, Discharge
	5. Trickle Charge	--
	6. Recondition Discharge	--
	7. Capacity Offset	7. Capacity Offset
	8. Temperature Sensor (optional)	8. Temperature Sensor (optional)
	9. Negative Slope	--
	10. End of Discharge	10. End of Discharge
	11. End of Recondition	--
	12. Charge Method	--
	--	13. Float Voltage
	--	14. Voltage Limit
	--	15. Topping Charge Plateau

Each C-Code item is explained further on the following pages.

Structure of C-Code for NiCd (Default shown)

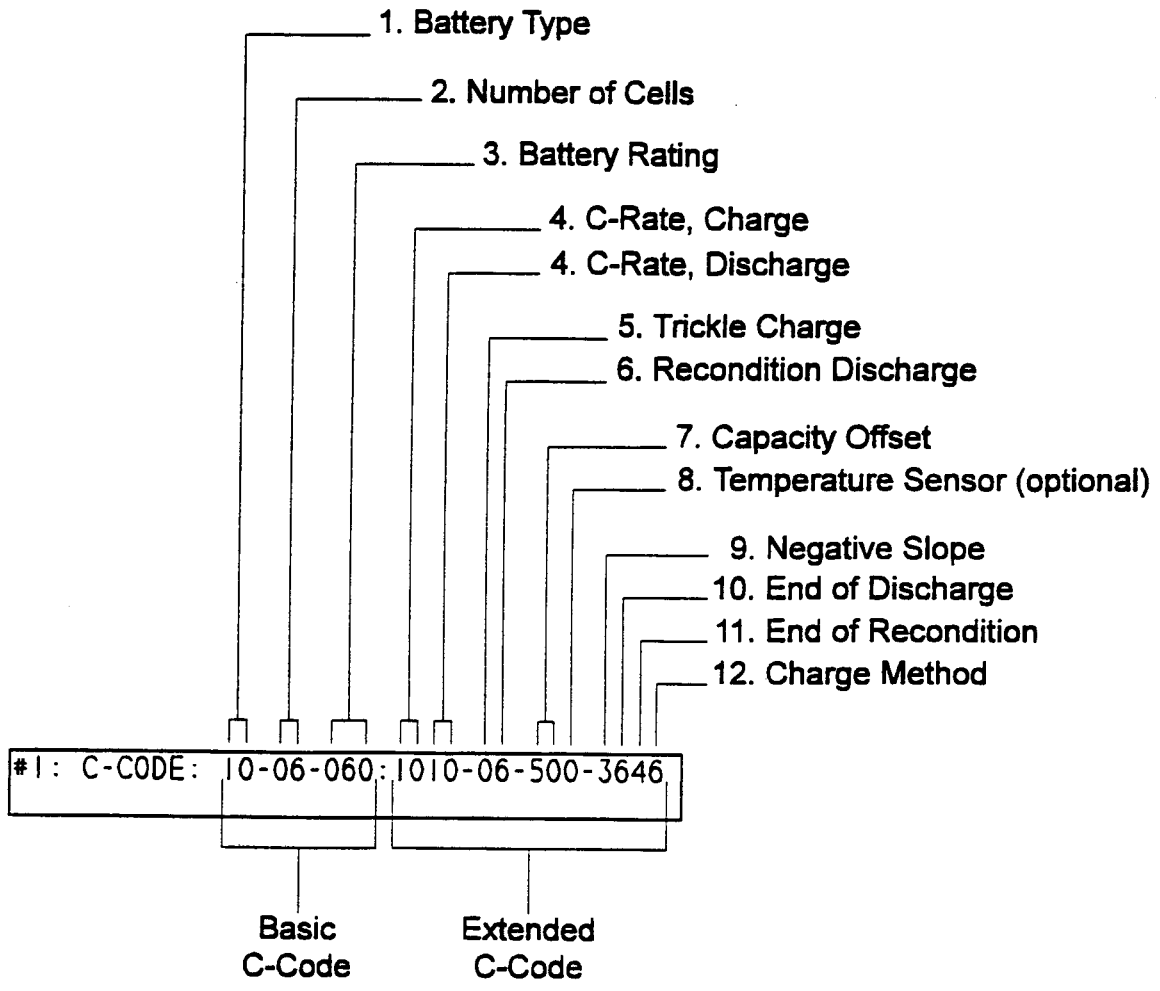


Figure 11.1

Structure of C-Code for NiMH (Default shown)

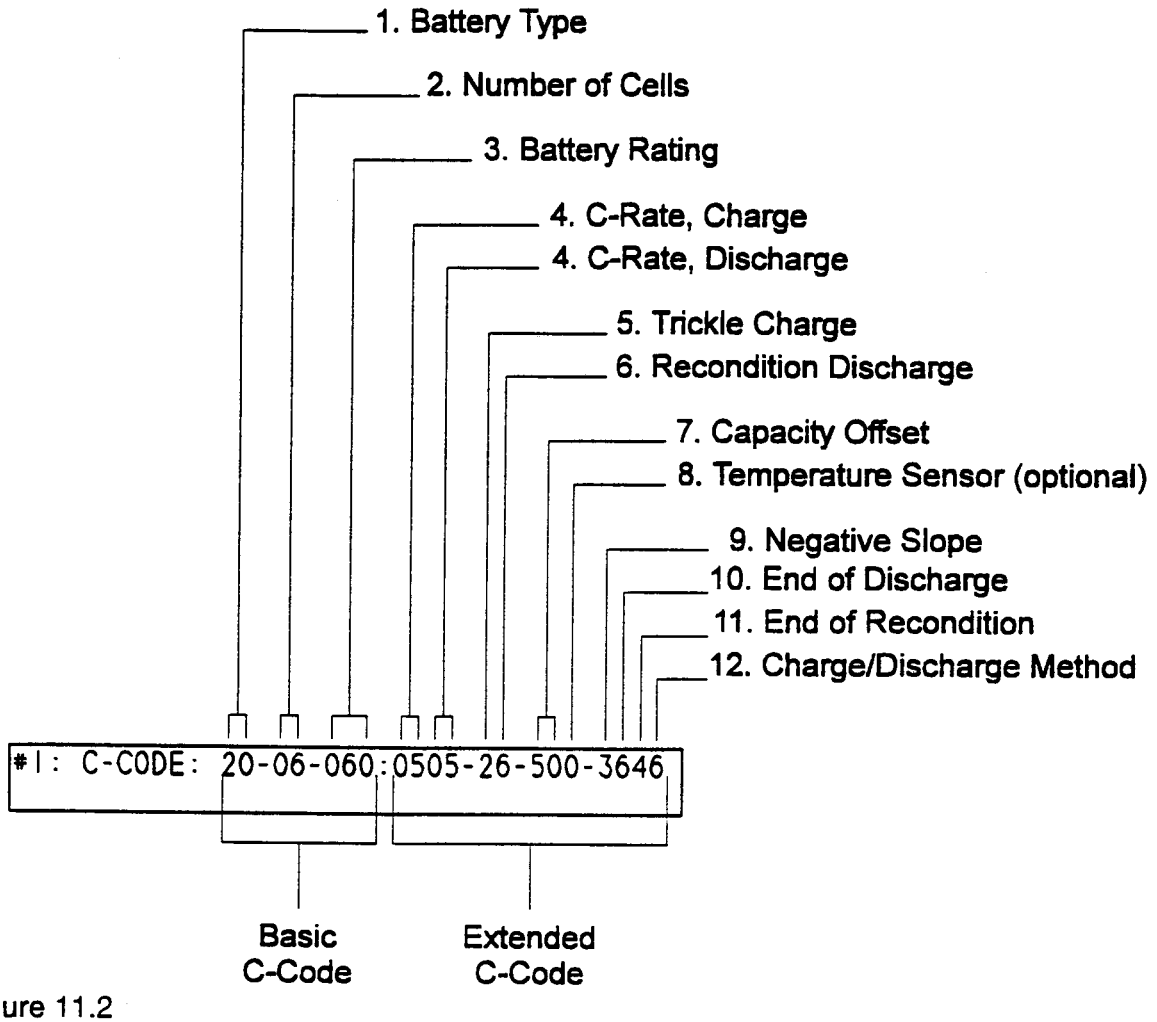


Figure 11.2

Structure of C-Code for SLA (Default shown)

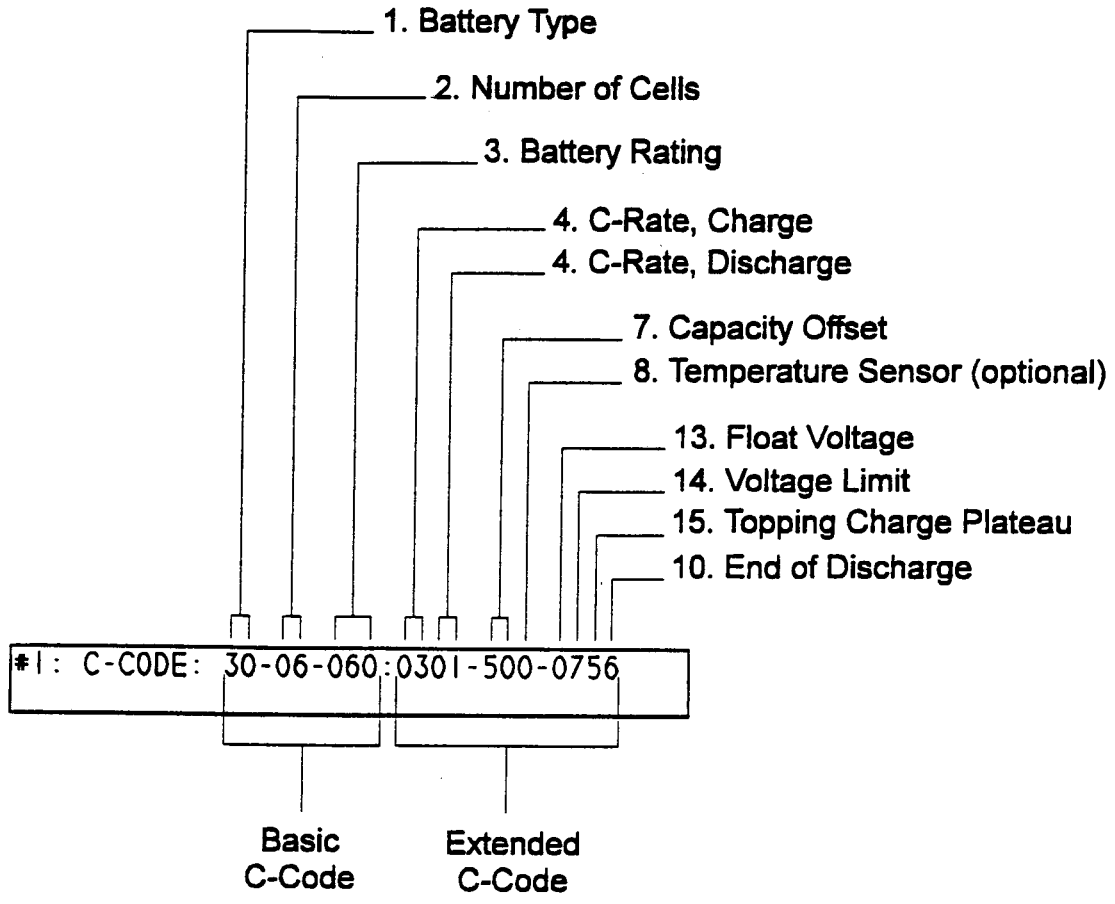


Figure 11.3

1. Battery Type

Each unique battery type (chemistry) is assigned a Battery Type Code. This code sets the Station to the appropriate mode of operation for the selected battery type.

BATTERY TYPE	CODE	C-RATE RESOLUTION
Nickel Cadmium (NiCd)	10	Standard
	11	Fine
Nickel Metal Hydride (NiMH)	20	Standard
	21	Fine
Sealed Lead Acid (SLA)	30	Standard
	31	Fine

Table 11.1

Definition

Each battery type can be selected in Standard or Fine C-Rate Resolution.

- Use Standard C-Rate Resolution (0.1C; to 3.9C) for
- Use Fine C-Rate Resolution (0.01C to 1.0C) for higher capacity batteries or application where fractional C-Rate values are required.

Limitation

If the Battery Type selected is not supported by the current version of firmware, the display shows: "TYPE: UNKNOWN".

2. Number of Cells

CODE		CODE		CODE	
1 cell	01	5 cells	05	9 cells	09
2 cells	02	6 cells	06	10 cells	10
3 cells	03	7 cells	07	11 cells	11
4 cells	04	8 cells	08	12 cells	12

Table 11.2

Number of cells specifies how many cells a battery pack contains.

Cell voltage definition

NiCd (Nickel Cadmium) = 1.25 volt per cell
NiMH (Nickel Metal Hydride) = 1.25 volt per cell
SLA (Sealed Lead Acid) = 2.00 volt per cell

Example A 6-cell NiCd has a nominal voltage of 7.5V; an 8-cell NiCd has 10.00V. A 6-cell SLA has a nominal voltage of 12.00V; an 8-cell SLA has 16.00V.

Equipment limitation

Maximum # of cells on Lead Acid = 8 cells or 16V
Maximum # of cells on NiCd or NiMH = 12 cells or 16V

Nominal cell voltage

Some manufacturers rate the cell voltage of the NiCd and NiMH batteries at 1.20V rather than 1.25V. This discrepancy results in a different battery voltage on the label only. The test results are not affected as the nominal cell voltage is an arbitrary assumed value.

Example An 8-cell NiCd battery specified at 1.20V per cell is labelled 9.6 volts. The same battery with the cell specified at 1.25V is labelled 10.00 volts. Both batteries are serviced in the same way.

How to calculate the number of cells

When establishing the number of cells of a NiCd or NiMH battery, divide the terminal voltage by either 1.20V or 1.25V; whichever divides into an even number. On SLA batteries divide the terminal voltage by 2.00V.

3. Battery Rating

The battery rating is the manufacturer's specified capacity of the battery. We have encoded this rating into a three-digit number. The Battery Rating Code is the battery rating divided by 25 mAh.

Battery Rating Code

mAh	Code	mAh	Code	mAh	Code	mAh	Code	mAh	Code	mAh	Code	mAh	Code
		1025	041	2050	082	4100	164	8100	324	12100	484	16100	644
		1050	042	2100	084	4200	168	8200	328	12200	488	16200	648
		1075	043	2150	086	4300	172	8300	332	12300	492	16300	652
		1100	044	2200	088	4400	176	8400	336	12400	496	16400	656
		1125	045	2250	090	4500	180	8500	340	12500	500	16500	660
		1150	046	2300	092	4600	184	8600	344	12600	504	16600	644
		1175	047	2350	094	4700	188	8700	348	12700	508	16700	668
200	008	1200	048	2400	096	4800	192	8800	352	12800	512	16800	672
225	009	1225	049	2450	098	4900	196	8900	356	12900	516	16900	676
250	010	1250	050	2500	100	5000	200	9000	360	13000	520	17000	680
275	011	1275	051	2550	102	5100	204	9100	364	13100	524	17100	684
300	012	1300	052	2600	104	5200	208	9200	368	13200	528	17200	688
325	013	1325	053	2650	106	5300	212	9300	372	13300	532	17300	692
350	014	1350	054	2700	108	5400	216	9400	376	13400	536	17400	696
375	015	1375	055	2750	110	5500	220	9500	380	13500	540	17500	700
400	016	1400	056	2800	112	5600	224	9600	384	13600	544	17600	704
425	017	1425	057	2850	114	5700	228	9700	388	13700	548	17700	708
450	018	1450	058	2900	116	5800	232	9800	392	13800	552	17800	712
475	019	1475	059	2950	118	5900	236	9900	396	13900	556	17900	716
500	020	1500	060	3000	120	6000	240	10000	400	14000	560	18000	720
525	021	1525	061	3050	122	6100	244	10100	404	14100	564	18100	724
550	022	1550	062	3100	124	6200	248	10200	408	14200	568	18200	728
575	023	1575	063	3150	126	6300	252	10300	412	14300	572	18300	732
600	024	1600	064	3200	128	6400	256	10400	416	14400	576	18400	736
625	025	1625	065	3250	130	6500	260	10500	420	14500	580	18500	740
650	026	1650	066	3300	132	6600	264	10600	424	14600	584	18600	744
675	027	1675	067	3350	134	6700	268	10700	428	14700	588	18700	748
700	028	1700	068	3400	136	6800	272	10800	432	14800	592	18800	752
725	029	1725	069	3450	138	6900	276	10900	436	14900	596	18900	756
750	030	1750	070	3500	140	7000	280	11000	440	15000	600	19000	760
775	031	1775	071	3550	142	7100	284	11100	444	15100	604	19100	764
800	032	1800	072	3600	144	7200	288	11200	448	15200	608	19200	768
825	033	1825	073	3650	146	7300	292	11300	452	15300	612	19300	772
850	034	1850	074	3700	148	7400	296	11400	456	15400	616	19400	776
875	035	1875	075	3750	150	7500	300	11500	460	15500	620	19500	780
900	036	1900	076	3800	152	7600	304	11600	464	15600	624	19600	784
925	037	1925	077	3850	154	7700	308	11700	468	15700	628	19700	788
950	038	1950	078	3900	156	7800	312	11800	472	15800	632	19800	792
975	039	1975	079	3925	158	7900	316	11900	476	15900	636	19900	796
1000	040	2000	080	4000	160	8000	320	12000	480	16000	640	20000	800

Table 11.1
(Battery ratings shown in mAh.)

Definition of battery capacity

Though the manufacturer specifies a battery capacity (which we define as battery "rating"), the true capacity is a measure of how much energy the battery can actually hold. This capacity is measured in milliamperes per hour (mAh) or amperes per hour (Ah). One Ah equals 1000mAh.

Example A fully-charged NiCd battery of 1500mAh (1.5Ah) is specified to provide a discharge current of 1500mA for 1 hour. If the battery can provide that current for 1 hour, the capacity is 100%.

Note For NiMH batteries, to achieve 100% capacity, the discharge current should be one-half of its total mAh rating; for SLA batteries, the discharge current should be one-twentieth of its total mAh rating (refer also to "4.C-Rate" in this chapter).

Scaling

The battery ratings can be entered in 25mA increments. Table 11.3 shows the most common battery ratings.

Range

NiCd, NiMH 200mAh to 20,000mAh

SLA 1000mAh to 24,975mAh

Limitation

If the battery rating is set too high, the display shows: "**BATTERY RATING: EXCEEDS MAXIMUM**". If the battery rating is below 200mA (008) for NiCd and NiMH batteries or 1000mAh (040) for SLA batteries, the display shows:"**BATTERY RATING: TOO LOW**". Either of these conditions results in an invalid C-Code.

4. C-Rate

Definition

C-Rate is a number representing the ratio of charge or discharge current to the battery rating. By lowering the C-Rate, the charge and discharge currents are reduced. The service time is prolonged accordingly.

Example A discharge time of a battery with 100% capacity is one hour if discharged at 1C. The discharge time of a battery with 50% capacity is 30 minutes at 1C. If discharged at a lower C-Rate of 0.5C, the discharge time for 100% capacity is two hours.

C-Rate set too high

If the C-Rate is set too high:

- The battery gets too warm during service
- Capacity readings are low.

Auto-scale

The maximum charge and discharge current of the C4000 is limited to 2A. If the Extended C-Code is set to the defaults for that battery type and a higher current is entered, the C4000 automatically selects a C-Rate that scales the current down to 2A or the next closest value.

Recommended C-Rate

NiCd Most standard NiCd batteries of up to 1800mAh can be charged and discharged at 1C. Ultra high capacity NiCd should be serviced at a lower C-Rate. 0.7C or 0.5C is recommended. Refer to the battery manufacturer's specifications for recommended C-Rates.

NiMH The C4000 default C-Rate setting for most NiMH batteries is 0.5C. Refer to the battery manufacturer's specifications for recommended charge and discharge rates.

SLA The battery manufacturers rate the SLA at a 20-hour discharge or 0.05C. Since this slow discharge is not practical when analyzing SLA batteries, the default C-Rate settings of the C4000 have been increased to 0.3C for charge and 0.1C for discharge. Refer to the battery manufacturer's specifications for recommended charge and discharge rates.

How to set Battery Rating and C-Rate

- Always set the Battery Rating as specified by the batt manufacturer.
- Set the recommended charge and discharge C-Rates afterwards.

How accurate are the battery ratings specified by the manufacturer?

Battery manufacturers often over-rate their batteries by specifying the peak rating rather than the more realistic average rating. If the capacity readings on new batteries are consistently low, find out what the average battery rating is. Most warranty claims are based on the average rating. Average ratings are 10% to 15% lower than peak ratings.

Limitation

If the specified C-Rate results in a current above 2A, or the C-Rate is above 3.9C, the LCD indicates "**TOO HIGH**". The C-Code is invalid.

Caution Pay special attention when using a C-Rate higher than 1C. Only specialty batteries can be charged at a higher C-Rate. Aging batteries or those with mismatched cells may overheat.

Separate C-Rate setting for charge and discharge

The current that the battery is charged or discharged at can be set with the C-Rate. The charge and discharge C-Rates can be set independently. The first two digits control the charge C-Rate, the second two digits control the discharge C-Rate.

Which C-Rate Resolution should I use?

- Use Standard C-Rate Resolution for most applications
- Use Fine C-Rate Resolution for higher capacity batteries or application where fractional C-Rate values are required.
- Standard and Fine C-Rate Resolutions are set by selecting the appropriate Battery Type Code. Refer to "1. Battery Type" in this chapter.

Standard C-Rate Resolution
(Battery Type Codes 10, 20, 30)

CODE	CODE
0.1C 01	2.1C 21
0.2C 02	2.2C 22
0.3C 03	2.3C 23
0.4C 04	2.4C 24
0.5C 05	2.5C 25
0.6C 06	2.6C 26
0.7C 07	2.7C 27
0.8C 08	2.8C 28
0.9C 09	2.9C 29
1.0C* 10	3.0C 30
1.1C 11	3.1C 31
1.2C 12	3.2C 32
1.3C 13	3.3C 33
1.4C 14	3.4C 34
1.5C 15	3.5C 35
1.6C 16	3.6C 36
1.7C 17	3.7C 37
1.8C 18	3.8C 38
1.9C 19	3.9C 39
2.0C 20	

Table 11.4a
*Default setting is 1C.

Fine C-Rate Resolution
(Battery Type Codes 11, 21, 31)

CODE	CODE	CODE	CODE	CODE
0.01C 01	0.21C 21	0.41C 41	0.61C 61	0.81C 81
0.02C 02	0.22C 22	0.42C 42	0.62C 62	0.82C 82
0.03C 03	0.23C 23	0.43C 43	0.63C 63	0.83C 83
0.04C 04	0.24C 24	0.44C 44	0.64C 64	0.84C 84
0.05C 05	0.25C 25	0.45C 45	0.65C 65	0.85C 85
0.06C 06	0.26C 26	0.46C 46	0.66C 66	0.86C 86
0.07C 07	0.27C 27	0.47C 47	0.67C 67	0.87C 87
0.08C 08	0.28C 28	0.48C 48	0.68C 68	0.88C 88
0.09C 09	0.29C 29	0.49C 49	0.69C 69	0.89C 89
0.10C 10	0.30C 30	0.50C 50	0.70C 70	0.90C 90
0.11C 11	0.31C 31	0.51C 51	0.71C 71	0.91C 91
0.12C 12	0.32C 32	0.52C 52	0.72C 72	0.92C 92
0.13C 13	0.33C 33	0.53C 53	0.73C 73	0.93C 93
0.14C 14	0.34C 34	0.54C 54	0.74C 74	0.94C 94
0.15C 15	0.35C 35	0.55C 55	0.75C 75	0.95C 95
0.16C 16	0.36C 36	0.56C 56	0.76C 76	0.96C 96
0.17C 17	0.37C 37	0.57C 57	0.77C 77	0.97C 97
0.18C 18	0.38C 38	0.58C 58	0.78C 78	0.98C 98
0.19C 19	0.39C 39	0.59C 59	0.79C 79	0.99C 99
0.20C 20	0.40C 40	0.60C 60	0.80C 80	1.00C* 00

Table 11.4b

5. Trickle Charge (NiCd, NiMH)

	CODE
1%	1
2%	2
3%	3
4%	4
5%	5
6%	6
7%	7
8%	8
9%	9
10%*	0

Table 11.5 *Default

Trickle charge maintains the NiCd and NiMH battery in full charge state after fast-charge. The trickle charge is expressed as a percentage of the rated battery capacity.

Recommended Setting On batteries with a rating of 1800mAH and below, the trickle charge is commonly set between 5% to 10% of the rated capacity. For larger batteries, a lower percentage is used.

Battery Temperature When in trickle charge, the battery should remain cool. If the battery feels warm, reduce the trickle charge current. Typical battery temperature on trickle charge should be 5°C above ambient.

Minimum Trickle Charge On a NiCd battery, a 5% trickle charge at 20°C(68°F) compensates for the self-discharge. 10% keeps the battery at full capacity.

6. Recondition Discharge (NiCd, NiMH)

	CODE
2%	1
4%	2
6%	3
8%	4
10%	5
12%*	**6**
14%	7
16%	8
18%	9
20%	0

Table 11.6 *Default

Recondition Discharge is a slow deep discharge applied below the end-of-discharge voltage threshold. During this gradual depletion of the remaining energy, the crystalline build-up (memory) on the cell plates dissolves and the NiCd battery is commonly restored.

Definition The set figure in Table 11.6 is a percentage of the battery current rating (at one volt per cell).

Speed and safety The best compromise between speed, effectiveness and safety is a Recondition Discharge of 12%. This setting is small enough to avoid damage if cell reversal occurs and is large enough to achieve a reasonable short Recondition Discharge time.

Scaling

The Recondition Discharge current decreases with the cell voltage (simulating resistive load).

Limitation

If the Recondition Discharge is set too high, the LCD indicates "**TOO HIGH**". The C-Code is invalid.

Application

Recondition Discharge is applied to the NiCd and NiMH battery families only.

7. Capacity Offset

The Capacity Offset corrects the capacity readings when discharging the battery at a higher or lower rate than specified by the battery manufacturer.

Negative Capacity Offset

CODE	CODE	CODE	CODE	CODE
0%* 50	-10% 40	-20% 30	-30% 20	-40% 10
-1% 49	-11% 39	-21% 29	-31% 19	-41% 09
-2% 48	-12% 38	-22% 28	-32% 18	-42% 08
-3% 47	-13% 37	-23% 27	-33% 17	-43% 07
-4% 46	-14% 36	-24% 26	-34% 16	-44% 06
-5% 45	-15% 35	-25% 25	-35% 15	-45% 05
-6% 44	-16% 34	-26% 24	-36% 14	-46% 04
-7% 43	-17% 33	-27% 23	-37% 13	-47% 03
-8% 42	-18% 32	-28% 22	-38% 12	-48% 02
-9% 41	-19% 31	-29% 21	-39% 11	-49% 01

Table 11.7a *Default

Positive Capacity Offset

CODE	CODE	CODE	CODE	CODE
0%* 50	+10% 60	+20% 70	+30% 80	+40% 90
+1% 51	+11% 61	+21% 71	+31% 81	+41% 91
+2% 52	+12% 62	+22% 72	+32% 82	+42% 92
+3% 53	+13% 63	+23% 73	+33% 83	+43% 93
+4% 54	+14% 64	+24% 74	+34% 84	+44% 94
+5% 55	+15% 65	+25% 75	+35% 85	+45% 95
+6% 56	+16% 66	+26% 76	+36% 86	+46% 96
+7% 57	+17% 67	+27% 77	+37% 87	+47% 97
+8% 58	+18% 68	+28% 78	+38% 88	+48% 98
+9% 59	+19% 69	+29% 79	+39% 89	+49% 99

Table 11.7b *Default

When to use it

The SLA battery is commonly rated at a 20-hour discharge. Faster discharge rates lower the capacity readings.

Since it is not practical to use a 20-hour rate when analyzing a battery, a faster discharge rate is applied. The derived capacity, which will be lower than specified, can mathematically be corrected with the capacity offset.

Example of Positive Capacity Offset

A SLA is specified to produce 100% capacity at a 20-hour discharge. If the battery is discharged in 5 hours, at four times the current, the capacity will be 70% typical. A positive offset of 30% can be added to correct for the discrepancy.

Example of Negative Capacity Offset

Likewise, a NiCd is specified to provide 100% capacity in a one-hour discharge.

If the battery is discharged in 5 hours, at one fifth of the current, the capacity will be more than 100%. negative offset can be added to correct for the discrepancy.

What does the Capacity Offset do?

The Capacity Offset does nothing more than "tamper" with the derived figure by artificially increasing (or decreasing) the test result by a specified percentage. The C4000 allows adding to, and subtracting from, the battery capacity in 1% steps.

With no capacity offset applied, the code remains at the default setting of "50" (0 offset); "49" refers to -1%; "51" refers to +1%. "99" represents the maximum positive offset of +49%.

The amount of Capacity Offset necessary can be derived from the battery manufacturer's specifications.

Note
Applying the Capacity Offset does not improve the battery capacity; it merely adjusts the capacity calculation if discharged at a higher than specified rate. Adding the Capacity Offset does not alter the way the battery is serviced.

It is not mandatory to add the Capacity Offset.

8. Temperature Sensor (optional)

	CODE
Disabled*	**0**
N.T.C., °C	1
P.T.C., °C	2
N.T.C., °F	3
P.T.C., °F	4
undefined	5
undefined	6
undefined	7
undefined	8
undefined	9

Table 11.8 * Default

Note The temperature sensor is recommended if the battery is serviced outside the temperature range of 5°C to 35°C (41°F to 95°F). If the battery is serviced at room temperature, sensing of the battery temperature is not required.

Definition The temperature sensor measures the cell temperature of the battery. The sensor may be installed in the battery or be placed external to the battery.

The sensor inhibits fast-charge outside the operational temperature range of 5°C to 45°C (41°F to 113°F). The temperature can be displayed in °C or °F.

Caution A battery should not exceed 45°C (113°F) for a prolonged time.

9. Negative Slope (NiCd, NiMH)

	CODE
undefined	0
undefined	1
24mV/cell	2
32mV/cell*	**3**
40mV/cell	4
48mV/cell	5
56mV/cell	6
64mV/cell	7
undefined	8
undefined	9

Table 11.9 *Default

The Negative Slope is a measure of the voltage drop that occurs when a NiCd battery reaches full-charge. The fast-charge is terminated when the voltage drop reaches the pre-set value. The Negative Slope can be adjusted with Table 11.9.

Recommended Setting

Higher Increasing the Negative Slope delays termination of the fast-charge, causing the battery to heat up towards the end of the charge cycle.

Lower Decreasing the Negative Slope may terminate the charge prematurely on the following conditions:

- Batteries with 1 to 4 cells are serviced
- Battery has voltage fluctuations due to instabilities.

Caution A NiCd cell should not exceed 45° (113°F) for a prolonged period.

10. End of Discharge

NiCd, NiMH

NiCd	CODE
0.76V/cell	0
0.80V/cell	1
0.84V/cell	2
0.88V/cell	3
0.92V/cell	4
0.96V/cell	5
1.00V/cell*	**6**
1.04V/cell	7
1.08V/cell	8
1.12V/cell	9

Table 11.10a *Default

Sealed Lead Acid

Lead Acid	CODE
1.36V/cell	0
1.43V/cell	1
1.49V/cell	2
1.56V/cell	3
1.62V/cell	4
1.68V/cell	5
1.75V/cell*	**6**
1.81V/cell	7
1.88V/cell	8
1.94V/cell	9

Table 11.10b *Default

The end-of-discharge voltage is the threshold point at which the discharge is terminated. The battery voltage is measured in average cell voltage.

Recommended setting Most NiCd and NiMH battery powered devices are designed to operate down to a supply voltage of 1 volt per cell (1.75 V/cell for SLA). If a different minimum operating voltage is required, the end-of-discharge threshold point can be changed with Table 11.10a. For SLA batteries, refer to Table 11.10b.

11. End of Recondition (NiCd, NiMH)

NiCd	CODE
undefined	0
undefined	1
undefined	2
undefined	3
0.4V/cell*	**4**
0.5V/cell	5
0.6V/cell	6
0.7V/cell	7
0.8V/cell	8
disable	9

Table 11.11 *Default

The End-of-Recondition voltage is the threshold point at which the Recondition Discharge is terminated. The battery voltage is measured in average cell voltage.

Recommended setting The minimum required setting to restore a NiCd battery affected by "memory" is 0.6 volt per cell. The default setting of C4000 is 0.4V/cell.

Best results
NiCd Recondition is most effective on NiCd batteries.

NiMH More information is required to determine the effect of recondition on NiMH batteries.

SLA The SLA cannot be reconditioned with deep discharge.

12. Charge Method (NiCd, NiMH)

	CODE
DC	0
0%	1
5%	2
6%	3
7%	4
8%	5
9%*	**6**
10%	7
11%	8
12%	9

Table 11.12 *Default

The C4000 allows various charge methods to optimize the charge efficiency of the battery being serviced.

Definition
DC Charge Code 0 is used to charge batteries that cannot accept pulse charge. For example: intrinsically safe battery which contain a low rated internal fuse.

Caution The minimum charge or trickle-charge current on DC Charge (Code 0) is 200mA. Do not use DC Charge on a battery of less than 2000mAh as the trickle charge current cannot be met, resulting in an invalid C-Code.

Pulse charge Code 1 is a pulse charge without Reverse Load.

Reverse Load Code 2 through 9 apply the Reverse Load Charge Method. The Reverse Load Charge intersperses discharge currents between the charge pulses. This push-pull action promotes the recombination of gases generated during charge. Reverse Load is applied on fast-charge and trickle charge.

Recommended setting Best results have been achieved with a setting of 9%. Use a lower setting for NiCds with ratings of 500mAh and less.

Limitation The Reverse Load current is limited to 250mA. If a larger current is requested, the LCD indicates "SCALED".

Example A 4000mAh battery set to a Reverse Load of 9% would apply a Reverse Load current of 360mA. Since 360mA is above the acceptable level, the C4000 scales the current to 250mA. The display shows "9% SCALED", meaning that the setting is 9% but the current has been scaled down.

13. Float Voltage (SLA)

	CODE
2.15V	8
2.20V	9
2.25V*	**0**
2.30V	1
2.35V	2
2.40V	3
2.45V	4
undefined	5
undefined	6
undefined	7

Table 11.13 *Default

The float charge maintains the SLA battery at full charge state. The float charge is applied after the battery is fully charged.

Recommended setting The manufacturers recommend float voltage is 2.25 to 2.30 volt.

Equipment limitations Due to the very low current requirements during float charge, the C4000 may not be able to provide a small enough current to maintain the cell voltage at 2.25V. The float charge voltage may be slightly higher. On a smaller SLA battery, a cell voltage of 2.35V/cell instead of 2.25V/cell may be observed.

Temperature while in Float Charge If the battery generates heat during prolonged float charge, remove the battery from the analyzer.

14. Voltage Limit (SLA)

	CODE
undefined	0
undefined	1
undefined	2
2.20V/cell	3
2.25V/cell	4
2.30V/cell	5
2.35V/cell	6
2.40V/cell*	7
2.45V/cell	8
2.50V/cell	9

Table 11.14 *Default

The SLA charge method is based on voltage limit. (In comparison, the NiCd and NiMH are based on current limit). The C4000 charges the SLA battery at the specified current until the set voltage threshold is reached.

Recommended setting The recommended voltage limit is 2.30V to 2.45V per cell. Refer to the battery manufacturer's specifications for the recommended setting. Observe the ambient temperature when selecting the voltage limit.

Slow charge If a slow charge is desired, or the battery temperature is likely to reached 30°C (86°F) or higher, use 2.35V/cell.

Fast charge If a fast charge is desired and the battery temperature will remain below 30°C (86°F), use 2.40V/cell.

Caution Do not use a voltage limit of 2.40V/cell or higher if the battery temperature is likely to reach 30°C (86°F).

Full-charge detection

After the voltage limit is reached, the charge current decreases. The decrease continues over several hours until it levels off and forms a plateau. At this point, the SLA battery is considered fully charged.

Charge time

The charge time at the default C-Rate setting of 0.3C is 10 hours typical. The charge cycle is part of two stages:

Stage 1
Constant current charge

Maximum charge current is applied until the voltage limit is reached. Typical time is 5 hours.

Stage 2
Topping charge

Charge current starts to drop. Typical time until the battery is fully saturated and the current reaches a low plateau is 5 hours.

Additional information For more information on charging of SLA batteries, refer to a separate manual entitled "***Analyzing Rechargeable Batteries***".

Important Do not exceed the manufacturer's recommended charge current and voltage limit. Observe battery temperature range.

15. Topping Charge Plateau (SLA)

	CODE
0.10C	0
0.01C	1
0.02C	2
0.03C	3
0.04C	4
0.05C*	**5**
0.06C	6
0.07C	7
0.08C	8
0.O9C	9

Table 11.15 *Default

Definition The topping charge Plateau is applied to detect the full-charge state of the SLA battery

How it works The charge state that follows after reaching the Cell Voltage is referred to as the Topping Charge. During the Topping charge the current drops gradually and bottoms out after a few hours (refer also to "14. Voltage Limit (SLA)". The point at which the current no longer decreases but remains steady is referred to as the Topping Charge Plateau. Table 11.15 sets the threshold point to which the charge current must arrive at before forming the plateau .

Charge termination After the Topping Charge Plateau is reached, the battery is considered fully charged.

Battery condition The Topping Charge Plateau may differ depending on the condition of temperature of the battery.

Good battery The Topping Charge Plateau may be established at 0.02C or lower. This battery has low electrical leakage.

Old battery The Topping Charge Plateau may not be able to drop to set the threshold as set in Table 11.15. This battery has electrical leakage.

Warm battery The Topping Charge Plateau on a warm battery will be higher that on a cool battery.

Code 12 If the charge current cannot decrease to the set threshold level, Code 12 is shown. This battery is considered fully charged. The program will proceed to the next step. Observe the performance of this battery.

CHAPTER 12

DIAGNOSTICS

Introduction

The C4000 performs a number of diagnostic checks on power-up and during service. A system failure is detected and displayed on the LCD.

1. RAM/Clock/LCD Check

On power-up, the internal and external RAM, clock and LCD are checked.

If the internal RAM or the LCD fails, all READY and FAIL LEDs flash; the display is inactive.

If the external RAM check fails, the LEDs flash and the LCD reads:

```
*** FATAL SYSTEM ERROR ***
EXTERNAL RAM FAULT
```

Note On RAM failure, no batteries can be serviced.

As the next step, the real-time clock chip is checked (for units with Option-P). If in error, the LCD reads:

```
*** SYSTEM ERROR ***
REAL-TIME CLOCK ERROR, PRESS ANY KEY
```

Note Clock and print functions are inoperative; batteries can be serviced.

Reason Bad clock chip.

As the next step, the real non-volatile RAM is checked. If in error, the LCD reads:

```
*** SYSTEM ERROR ***
NON-VOLATILE RAM ERROR, PRESS ANY KEY
```

Note Data Retention has failed; batteries can be serviced.

Reason Bad back-up battery. Date/Time and Company Name may also be affected.

The system will try to correct the error and the message may not appear consistently. To clear the message, press any Display Key.

2. Start-up Messages

Start-up with no battery

When turning the C4000 on, the following messages are shown briefly:

If all diagnostic tests pass:

```
C4000 (C)1993 CADEX ELECTRONICS INC.
VERSION: 3.00; ** DIAGNOSTICS PASS **
```

If any diagnostic tests fail:

```
C4000 (C)1993 CADEX ELECTRONICS INC.
VERSION: 3.00; ** DIAGNOSTICS FAIL **
```

Start-up with battery (power failure)

When power is applied with a battery in, the C4000 assumes a power failure had occurred. The LCD reads:

Printer Output & Data Retention option not installed

```
POWER INTERRUPTED, PROGRAM(S) RESTARTED!
(PRESS ANY KEY)
```

Printer Output & Data Retention option installed

```
POWER INTERRUPTED, PROGRAM(S) RESUMED
(PRESS ANY KEY)
```

CHAPTER 13

SERVICE

1. Static Precautions

The micro chips used in the C4000 may be damaged by static charge if not handled properly. Static charge is generated through the contact of non- conductive materials such as plastic bags, synthetic clothing and carpeted floors.

When replacing fuses, back-up battery, EPROM or installing the Option-P, always pay attention to the static charge. It is recommended that a grounded wrist band be used. If a wrist band is not available, firmly grasp the metal sides of the housing with both hands before touching any components. Repeat after moving around.

2. Replacing Fuses

The C4000 is protected by three types of fuses:

Primary Fuse located in Power Entry Module.
Battery Fuse accessible through Fuse Cover on bottom.
Circuit Fuse can only be replaced by service technician.

Warning Before replacing any fuse, remove all test batteries from the unit, turn the unit off and disconnect the power cord. Replace with the same type of fuse.

Primary Fuse

The Primary Fuse is located in the power entry module on the back of the unit. To replace the fuse, disconnect the line cord and remove drawer with fuse.

Battery Fuse

Each Station (battery input) is protected by a Battery Fuse. There are four Battery Fuses. The fuses are accessible through the Fuse Cover on the bottom of the C4000.

Open fuse An open Battery Fuse condition is identified by the absence of charge or discharge current when a battery is in service. An appropriate fault code may also be shown.

Approved Replacement Fuses

Primary Fuse T1.5 Amp, 250 VAC (100 - 127V Line Voltage)
T0.8 Amp, 250 VAC (220 - 240V Line Voltage)

Station Fuse 2.5 Amp fast blow, 250 VAC

Caution Using an unapproved fuse may cause the device to fail.

Circuit Fuse

The Circuit Fuse is soldered on the PCB and can be replaced only by a qualified technician. In the unlikely event of an open Circuit Fuse, it is recommended that the unit be examined by an authorized service centre

Battery Fuse Location

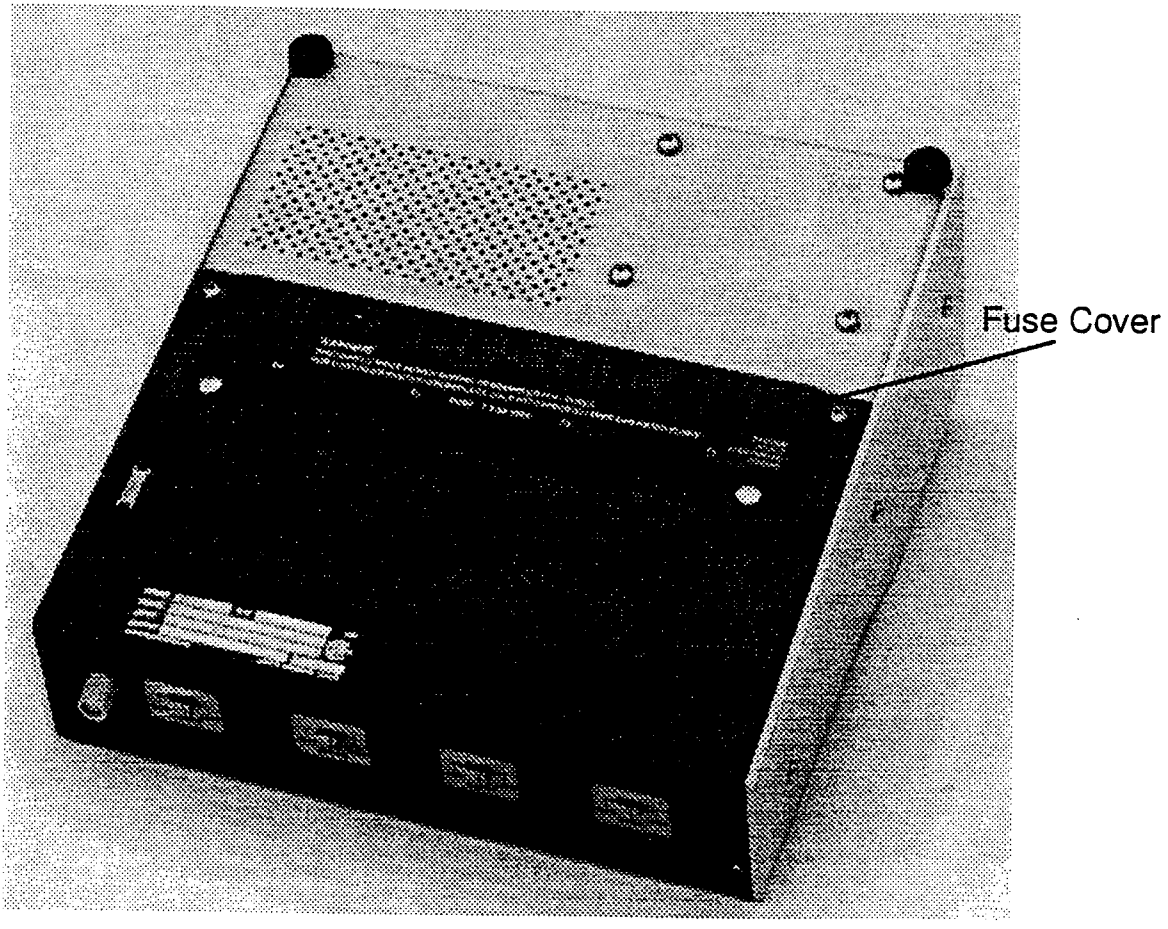


Figure 13.1

3. Replacing Back-up Battery

The Back-up battery is required if the C4000 is equipped with the Option-P. The battery retains Date/Time, Print Formats and other information when the power is turned OFF.

Life Span With the C4000 turned OFF, the battery will last for 2 to 3 years. With the unit ON, the battery will last for 10 years.

When to replace the Back-up Battery

Replace the Back-up Battery if the Date/Time setting is no longer retained with the unit turned OFF.

How to replace the Back-up Battery

Warning Before replacing the Back-up Battery, remove all test batteries, turn the unit OFF and disconnect the power cord. Replace with the same type of back-up battery.

1. Remove the right side plate of the C4000 by unscrewing the three 6-32 screws. The battery is located on the upper side of the Motherboard.

2. Gently lift the retainer arm which holds the battery and slide the used battery out.

3. When installing the new battery, observe the correct polarity.

   CAUTION DANGER OF EXPLOSION IF BACK-UP BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH SAME OR EQUIVALENT TYPE RECOMMENDED BY CADEX. DISCARD USED BATTERY ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.

4. Re-install the side plate.

5. Turn unit on. Check for correct sign-on message.

Non-volatile RAM ERROR Message

When the unit is first turned on after replacing the back-up battery, a non-volatile RAM ERROR message will appear. To continue, press any Display Key. Pressing the Key initializes the clock chip.

To verify correct operation, turn the power off and on again while batteries are being serviced. The battery data, date & time and print format should be retained - if not, check the back-up battery.

4. Replacing the EPROM

Identification

The EPROM is a 28-pin device mounted in a socket. The EPROM is the only chip marked with a label.

Important Replacement of the EPROM must be performed only by a qualified technician. Observe the static precautions when opening the C4000. Refer to "1. Static Precautions" in the chapter.

Warning Before replacing the Back-up Battery, remove all test batteries, turn the unit off and disconnect the power cord.

1. Remove plastic floor section by unscrewing 5 screws. (Two screws are located in the front rubber feet.)

   Caution Do not assert pressure on the Target Selector switch when removing or installing floor section.

2. Identify the EPROM and observe its orientation (refer to Figure 13.2 at the end of this chapter). Note the orientation of the notch at one end of the device.

3. Use a designated IC remover or small blade screw driver to gently lift the EPROM off the socket.

   Caution Take care in handling the EPROM. Do not bend the pins.

4. When installing the new EPROM, assure that <u>all</u> IC pins are firmly plugged into the IC socket. Insure that the notch is oriented towards the inside of the Motherboard.

5. Move all toggle switches on the front to the center position (CHARGE).

6. Re-install the lower housing. Make sure the toggle switches are seated properly by gently tugging them towards the bottom of the unit. Fasten screws.

7. Turn unit on. Check for correct sign-on message.

5. Installing OPTION-P

Important Replacement of the EPROM must be performed only by a qualified technician. Observe the static precautions when opening the C4000.

Option-P consists of:

EPROM accessible through bottom cover
Clock Chip accessible through bottom cover
Back-up Battery accessible through right side plate

Warning Before installing Option-P, remove all test batteries, turn the unit off and disconnect the power cord.

1. Remove plastic floor section by unscrewing 5 screws. (2 screws are located in the front rubber feet.)

Caution Do not assert pressure on the Target Selector switch when removing or installing the floor section.

Replace EPROM

2. Identify the EPROM and observe its orientation (refer to Figure 13.2 at the end of this chapter). Note the orientation of the notch at one end of device.

3. Use a designated IC remover or small blade screw driver to gently lift the EPROM off the socket.

4. When installing the replacement EPROM, assure that all IC pins are firmly plugged into the IC socket. Insure that the notch is oriented towards the inside of the Motherboard Layout.

Install clock chip

5. Ensure that jumper J4 is set correctly for the EPROM type installed. There are two types of EPROM's available: The 27C256 and the 27C512. Refer to the Motherboard Layout at the end of this chapter.

Note

- For the 27C256 the jumper should be installed between the center pin and the pin marked 256.
- For the 27C512 the jumper should be between the center pin and the pin marked 512.

Install clock chip 6. Install the clock chip in the 8 pin socket identified as U25. Refer to "6" Motherboard Layout" in this chapter. Observe the correct orientation.

Install back-up battery 7. Remove the right aluminum side plate and install the back-up battery. Observe the correct polarity.

CAUTION: DANGER OF EXPLOSION IF BACK-UP BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH SAME OR EQUIVALENT TYPE RECOMMENDED BY CADEX. DISCARD USED BATTERY ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.

8. Move all toggle switches on the front to the center position (CHARGE)

9. Re-install lower housing and side plate. Make sure the toggle switches are seated properly by gently tugging them towards the bottom of the unit.

10. Turn unit on. Check for correct sign-on message.

Non-volatile RAM ERROR message When the unit is first turned on after replacing the back-up battery, a non-volatile RAM ERROR message will appear. To continue, press any Display Key. Pressing the Key initializes the clock chip.

11. Set date and time. Select print format. Refer to CHAPTER 10 - OPTIONS

The Data Retention function is now active. The unit will hold the test results on a power failure and resume when the power is restored.

Verification To verify the correct operation, turn the power off for two minutes and on again while the batteries are being serviced. The battery data, Date/Time and print format should be retained -- if not, check the back-up battery.

6. Motherboard Layout

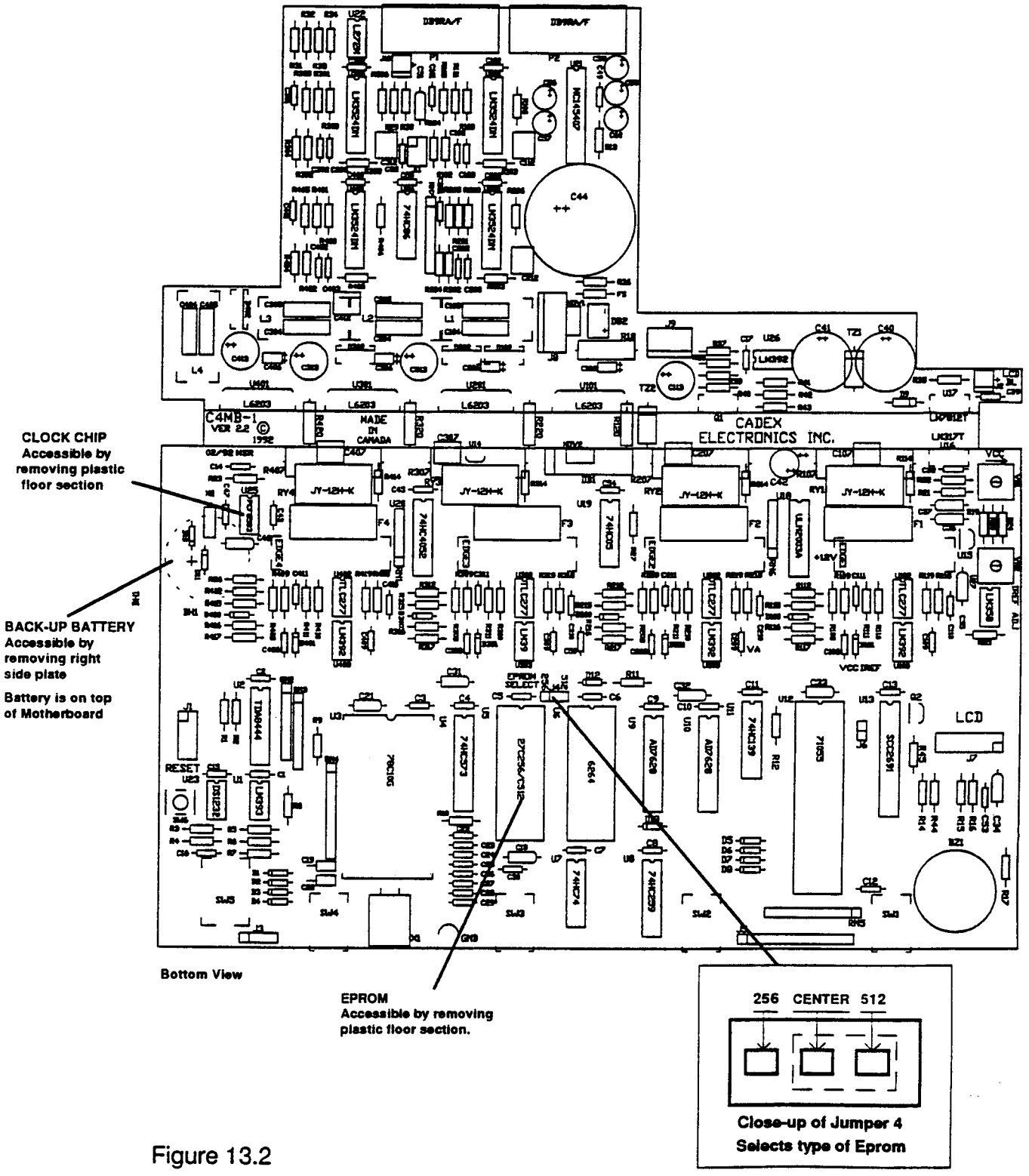


Figure 13.2

CHAPTER 14

SPECIFICATIONS

System	The C4000 services four batteries simultaneously. The batteries are tested at user-specified voltage and currents. Short and reverse polarity protected.
Battery Adapters	The batteries interface through Configured Cups and Smart Cables. The Battery Adapters are mechanically and electrically configured for a battery type. For a list of Battery Adapters refer to APPENDIX — BATTERY ADAPTER LISTING.
Programming	Battery parameters are stored in the adapters and can be reprogrammed through a menu-driven user interface. The battery code (C-Code) is grouped into two sections:
Basic C-Code	Selects battery chemistry, number of cells and battery rating. All other parameters are set to factory defaults unless changed.
Extended C-Code	Sets special parameters, they are: C-Rate, trickle charge & recondition current, capacity offset, full-charge detection, end-of-discharge & recondition, and charge methods
Power Supply	Four digitally-controlled switch mode drivers. 2A maximum charge and discharge current per driver. Intelligent overload protection. Maximum 80W continuous. Energy from discharging batteries is utilized to charge other batteries. Cooling fan engages at 45°C (113°F).
Battery Types	Chemistries supported: Nickel Cadmium (NiCd), Nickel Metal Hydride (NiMH), and Sealed Lead Acid (SLA).
Auto-scale	Allows servicing of batteries with a rating in excess of 2Ah. Scaling occurs through the analyzer's selection of lower charge and discharge C-Rates. Auto-scale is bypassed by entering a user-defined C-Rate.
Range	*NiCd* 1.25V to 15V, 200mAh to 20Ah. *NiMH* 1.25V to 15V, 200mAh to 20Ah. *SLA* 2V to 16V, 1 Ah to 25Ah.
Accuracy	Better than +/-2.5% at full scale.

Charge Method

Reverse Load Charge to promote recombination of gases generated during fast-charge (NiCd and NiMH batteries).

Program Selection

Prime Applies successive discharge/charge cycles until peak capacity is reached. Prepares new batteries for field use. Program duration is 4-8 hours.

Charge Fast-charge only. Typical charge time is 85 min (at 1C-Rate).

Auto Exercises battery and reconditions those unable to reach the user-defined target capacity.

Standby Maintains optimum battery performance if kept on charge for operational readiness. Every 30 days (6 months for Lead Acid), the battery is automatically exercised.

Custom Enables programming of any desired sequence of charge, discharge, recondition and trickle charge. The Custom Program allows testing of long-term reliability, self-discharge and more.

Throughput

Four batteries every 4 to 6 hours. Maintains a fleet of 160 batteries on recommended monthly maintenance schedule (based on two batches per day and 20 days per month).

Display

Three LEDs (RUN, READY and FAIL) and a two-line, 40-character, back-lit LCD with multiple display formats.

Global The Global Display indicates the status of all batteries; battery voltages are shown in bar graph format.

Detailed The Detailed Display reveals test results of each battery. Fault Codes (if any) are clearly explained.

Menu The Menu Display guides the user through modifying battery parameters and system set up.

Control Circuit

Microprocessor controlled; self-diagnostics with memory checking; multiple watch-dog protection.

Data Ports

Two RS-232C ports, one for printer output and one for computer interface. Requires Option-P to enable.

Power

Range ±10%, load 180W max.

Model CD44-1, 115VAC, 60Hz (North American Version).
Model CD44-2, 100/115/127VAC, selectable, 50-60Hz.
Model CD44-9, 220/230-240VAC, selectable, 50-60Hz.

Dimensions

(WxDxH) 240mm x 250mm x 100mm (9.5" x 10" x 4").

Weight

4.5kg (10 lb) typical.

Warranty

One (1) year on parts and labour.

Approvals

CSA.

Options

Option-P

Option-P contains printer output, computer interface and data retention. The printer generates service report and battery stick-on labels with date & time. The battery backed-up RAM retains test data on power outage and resumes program when power is restored.

Temperature Sensor

The Temperature Sensor is available for extreme temperature applications. This option is not required for normal operation.

Note Specifications are subject to change without notice.

APPENDIX

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
ASELSAN		5820 4813 0002	11.25	600	CC358B	10-09-024	4-1801
ASELSAN		5820 4813 0005	11.25	900	CC359C	10-09-036	4-1802
ASELSAN		7.2-1200	7.50	1200	CC357C	10-06-048:0808-06-500-3646	4-1799
ASELSAN		7.2-1700	7.50	1700	CC357C	10-06-068:0707-06-500-3646	4-1800
AST	Computer	230124-001 REV D	5.00	5000	CC232C	10-04-200	4-1548
AST	Computer	230219-001 REV A	5.00	5700	CC232C	10-04-228	4-1549
AVICOM	Radio	5N400AA-P1H	6.25	400	CC307A	10-05-016:1005-06-500-3646	4-1700
AVICOM	Radio	5N600AA-P1H	6.25	600	CC307A	10-05-024:1005-06-500-3646	4-1701
AVICOM	Radio	5N900AA-P1H	6.25	900	CC307B	10-05-036:1005-06-500-3646	4-1702
Alexander Batt.	EB-KJ3500	CL0016	7.50	750	CC185B	10-06-030	4-1462-01
Alexander Batt.	MVX500	CL9106	6.25	1070	CC239X	10-05-043	4-1567-01
Alexander Batt.	Minivox MVX500	CL9105	6.25	600	CC239X	10-05-024:0202-06-500-3646	4-1561-01
Alexander Batt.	P300	P805EB(S)	10.00	1200	CC317C	10-08-048	4-1745-02
Anton/Bauer	Video	NP-13 Plus	13.75	1700	CC159C	10-11-068	4-1503
Anton/Bauer	Video Camera	COMPAC 13	13.75	3000	CA210X	10-11-120	4-1509
Anton/Bauer	Video Camera	COMPAC 14	15.00	3000	CA210X	10-12-120	4-1508
Anton/Bauer	Video Camera	MAGNUM 13	13.75	5000	CA210X	10-11-200	4-1505
Anton/Bauer	Video Camera	MAGNUM 14	15.00	5000	CA210X	10-12-200	4-1504
Anton/Bauer	Video Camera	MAGNUM 14	15.00	5000	CD210X	10-12-200	4-1504A
Anton/Bauer	Video Camera	PROPAC 13	13.75	4000	CA210X	10-11-160	4-1507
Anton/Bauer	Video Camera	PROPAC 14	15.00	4000	CA210X	10-12-160	4-1506
Apple Computer	MacIntosh PowerBook	M5653	6.25	2500	CA267P	10-05-100:0606-06-500-3646	4-1614
Apple Computer	PowerBook	M1906	10.00	1800	CC365B	20-08-072	4-1803
Ascom	AK140 S	AK140 S1000	7.50	1000	CC320C	10-06-040	4-1708
Ascom	AK140 S	AK140 S600	7.50	600	CC309B	10-06-024	4-1707
Ascom	AK160 S	AK160 S1000	7.50	1000	CC310C	10-06-040	4-1710
Ascom	AK160 S	AK160 S700	7.50	700	CC310C	10-06-028	4-1709
Audiovox		BTR-300 (NiCd)	5.00	400	CC348B	10-04-016	4-1788
Audiovox		BTR600	7.50	400	CC347A	10-06-016	4-1787
Audiovox	MVX 750	BTE-700	5.00	1100	CC329C	20-04-044:0202-26-500-3646	4-1742
Audiovox	MVX 750	BTR-700	5.00	600	CC322B	20-04-024:0202-26-500-3646	4-1741
Audiovox	Minivox MVX500	BTE-500	6.25	1000	CC239X	10-05-040:0505-06-500-3646	4-1567
Audiovox	Minivox MVX500	BTR-500	6.25	600	CC239X	10-05-024:0202-06-500-3646	4-1561
Audiovox	PR100,PT300,CTX5000	BTR-40	7.50	600	CC173A	10-06-024	4-1444
Bendix/King		LAA-0109	10.00	1200	CC191B	11-08-048:4545-06-500-3641	4-1450
Bendix/King		LAA-0121	10.00	650	CC138B	10-08-026	4-1534
Bendix/King		LAA-0134	10.00	1200	CC138B	10-08-048	4-1129
Bendix/King	LPH5141,-5142	LAA-0105 (1200)	10.00	1200	CC138B	10-08-048	4-1457-01
Bendix/King	LPH5141,-5142	LAA-0105 (800)	10.00	800	CC138B	10-08-032	4-1457
Bendix/King	LPH5141,-5142	LAA100	10.00	450	CC138B	10-08-018	4-1127
Bendix/King	LPH5141,-5142	LAA105	10.00	800	CC138B	10-08-032	4-1128
Bendix/King	LPX2102	LAA-0125	10.00	1200	CC138B	10-08-048	4-1130
Cadex	C4000 Series	ADAPTER .187 DISCONN	0.00	0	UA-15		4-B011A
Cadex	C4000 Series	ADAPTER .250 DISCONN	0.00	0	UA-14		4-B009A
Cadex	C4000 Series	ADAPTER FOR AMP-CABL	0.00	0	UA-20		4-B003
Cadex	C4000 Series	ADAPTER FOR D-CABLE	0.00	0	PA-10		4-B001
Cadex	C4000 Series	AMP-CABLE 30in, OPEN	0.00	0	PE-25		4-B010
Cadex	C4000 Series	AMP-CABLE W/ALIG CLP	0.00	0	PE-21		4-B006
Cadex	C4000 Series	CA W/30" CABLE, OPEN	0.00	0	UA-25		4-B010A
Cadex	C4000 Series	CA, COAX POWER JACK	0.00	0	UA-23		4-B013
Cadex	C4000 Series	CA, STD BANANA JACK	0.00	0	UA-22		4-B012
Cadex	C4000 Series	CA-CABLE W/ALIG CLIP	0.00	0	UA-11		4-B005B
Cadex	C4000 Series	D-CABLE .187 DISCONN	0.00	0	UD-15		4-B011
Cadex	C4000 Series	D-CABLE .250 DISCONN	0.00	0	UD-14		4-B009
Cadex	C4000 Series	D-CABLE W/ALIG. CLIP	0.00	0	UD-11		4-B005
Cadex	C4000 Series	D-CABLE W/BANANA PLG	0.00	0	UD-12		4-B007
Cadex	C4000 Series	D-CABLE W/MINI B PLG	0.00	0	UD-13		4-B008

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Cadex	C4000 Series	UNIV. CA-CABLE, OPEN	0.00	0	UA-10		4-8002A
Cadex	C4000 Series	UNIV. D-CABLE, OPEN	0.00	0	UD-10		4-8002
Cadex	C4000 Series	UNIV.AMP-CABLE, OPEN	0.00	0	PE-20		4-8004
CamGear	Video Camera	8418	12.00	2000	CC198C	30-06-080	4-1537
Canon	Video Camera	BP-E718	6.25	1800	CC231C	10-05-072	4-1547
Canon	Video Camera	BP-E722	6.25	2200	CA276P	10-05-088:0505-06-500-3646	4-1631
Centurion	LPH5141,-5142	KR0105E (1200)	10.00	1200	CC138B	10-08-048	4-1457-02
Centurion	SH405G2	IC0035B	10.00	600	CC157B	10-08-024	4-1366-01
Cine 60	Powerbelt	Cannon XLR 4-PIN	0.00	0	CD182X	10-00-000	4-1470
Cine 60	Powerbelt	Cannon XLR 4-PIN	0.00	0	CA182X	10-00-000	4-1470A
Cine 60	Powerbelt 12V Pin1/3	Cannon XLR 5-PIN	12.50	0	CD209X	10-10-000	4-1510
Cleartone Telec		BP6	12.50	450	CC248B	10-10-018	4-1550
Cleartone Telec		BP7	12.50	1200	CC248B	10-10-048	4-1551
Diamondtel		FZ-1186A	6.25	400	CC258B	10-05-016	4-1659
Diamondtel	95T Transportable	BAT-95	10.00	1700	CC194C	10-08-068	4-1515
Diamondtel	DT-22X	HCBP-22	6.25	900	CC258B	10-05-036	4-1661
Diamondtel	Mesa 90X Series	Bat-90	7.50	700	CC101B	10-06-028	4-1514
Diamondtel	Mesa 92 Series	FZ-1031A	6.25	1400	CC195B	10-05-056	4-1516
Diamondtel	Mesa 99X Series	BP-99	6.25	400	CC178X	10-05-016	4-1475
Dual-Voltage	Video Camera	DV-6077P	6.25	2000	CA276P	10-05-080:0505-06-500-3646	4-1632
E.F. Johnson		023-5800-156	12.50	800	CC251B	10-10-032	4-1112
E.F. Johnson		023-8565-171	7.50	1000	CC220B	10-06-040	4-1545
E.F. Johnson		023-8790-620	12.50	1000	CC182B	10-10-040	4-1111
E.F. Johnson		587-5900-002	7.50	1300	CC321C	10-06-052	4-1751
E.F. Johnson	LTR 8560	587-8565-171	7.50	1400	CC220B	10-06-056:0707-06-500-3646	4-1674
E.F. Johnson	Trunking Radio	023-8560-160	7.50	1000	CC220B	10-06-040	4-1425
E.F. Johnson	Trunking Radio	023-8560-170	7.50	1000	CC220B	10-06-040	4-1110
E.F. Johnson	Viking XR	585-5000-025	7.50	1400	CC351C	10-06-056:0707-06-500-3646	4-1792
ENERGEX SYSTEMS	Video Camera	XAB 13	13.75	5000	CA210X	10-11-200	4-1507-01
ENERGEX SYSTEMS	Video Camera	XAB 14	15.00	5000	CA210X	10-12-200	4-1506-01
ENERGEX SYSTEMS	Video Camera	XCAB 13	13.75	2400	CA210X	10-11-096	4-1509-01
ENERGEX SYSTEMS	Video Camera	XCAB 14	15.00	2400	CA210X	10-12-096	4-1508-01
ENERGEX SYSTEMS	Video Camera	XP90	12.50	5000	CA161X	10-10-200	4-1748
Ericsson		BKB 193 014	6.25	400	CC250B	10-05-016	4-1582
Ericsson		BKB 193 026	6.25	500	CC315B	20-05-020	4-1719
Ericsson		BKB 193 037	6.25	900	CC130B	10-05-036	4-1618
Ericsson	EH237, GH337	BKB 193 029	6.25	500	CC315B	20-05-020	4-1804
Ericsson	EH237, GH337	BKB 193 077	6.25	1100	CC315B	20-05-044	4-1805
Ericsson	Hotline	BKB 193 009	6.25	1200	CC233B	10-05-048	4-1662
Ericsson	Hotline	BKB 193 033	6.25	750	CC130B	10-05-030	4-1418
Ericsson	MOBILE 1331	BKB 193 016	6.25	800	CC130B	10-05-032	4-1667
Ericsson	OLIVIA	BKB 193 003	6.25	750	CC130B	10-05-030	4-1466
Ericsson	OLIVIA	BKB 193 008	6.25	1200	CC233B	10-05-048	4-1552
Ericsson	P300	ERICSSON 1911	10.00	1500	CC317C	10-08-060	4-1745
Ericsson	P400	19A704850 P7	7.50	1200	CC102B	10-06-048	4-1030-01
Ericsson	P400	19A704860 P6	7.50	1700	CC103C	10-06-068	4-1413-01
Ericsson/G.E.		BKB 193 076	6.25	550	CC315B	20-05-022	4-1719-01
Ericsson/G.E.	CT700	BKB 193 031	6.25	1100	CC315B	20-05-044	4-1774
Ericsson/G.E.	M-RK	19A149838 P1	7.50	1200	CC292B	10-06-048:0707-06-500-3646	4-1668
Ericsson/G.E.	M-RK	344A3278 P1	7.50	1700	CC293C	10-06-068:0707-06-500-3646	4-1669
Ericsson/G.E.	M-RK	344A3487 P1	7.50	600	CC292B	10-06-024	4-1715
Ericsson/G.E.	MONOGRAM	344A4506 P1	11.25	600	CC269B	10-09-024	4-1716
Ericsson/G.E.	MONOGRAM	344A4506 P3	11.25	1200	CC269B	10-09-048	4-1717
Ericsson/G.E.	MPD	167D5417 G1	7.50	1700	CC105C	10-06-068	4-1035
Ericsson/G.E.	MPD	19A704850 P4	7.50	800	CC102A	10-06-032	4-1029

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Ericsson/G.E.	MPD	19A704850 P5	7.50	800	CC102A	10-06-032	4-1028
Ericsson/G.E.	MPD	19A704850 P6	7.50	1200	CC102B	10-06-048	4-1691
Ericsson/G.E.	MPD	19A704850 P7	7.50	1200	CC102B	10-06-048	4-1030
Ericsson/G.E.	MPD	19A704860 P4	7.50	1200	CC103B	10-06-048	4-1033
Ericsson/G.E.	MPD	19A704860 P5	7.50	1200	CC104B	10-06-048	4-1031
Ericsson/G.E.	MPD,TPX,PLS,MPA	19A704850 P3	7.50	800	CC102A	10-06-032	4-1036
Ericsson/G.E.	MPD,TPX,PLS,MPA	19A704860 P3	7.50	1200	CC103B	10-06-048	4-1037
Ericsson/G.E.	MPD,TPX,PLS,MPA	19A704860 P6	7.50	1700	CC103C	10-06-068	4-1413
Ericsson/G.E.	MPD,TPX,PLS,MPA	19A704860 P7	7.50	1700	CC103C	10-06-068	4-1038
Ericsson/G.E.	MPI	19D900639 G2	7.50	450	CC106A	10-06-018	4-1039
Ericsson/G.E.	MPI	19D900639 G3	10.00	450	CC106A	10-08-018	4-1040
Ericsson/G.E.	MPI	19D900639 G4	7.50	450	CC106A	10-06-018	4-1338
Ericsson/G.E.	MPI	19D900639 G6	7.50	600	CC106A	10-06-024	4-1347
Ericsson/G.E.	MPI	19D900639 G7	10.00	600	CC106A	10-08-024	4-1134
Ericsson/G.E.	MPR, MPS	19D429763 G1	7.50	750	CC107A	10-06-030	4-1042
Ericsson/G.E.	MPR, MPS	19D429763 G2	7.50	750	CC108B	10-06-030	4-1041
Ericsson/G.E.	MPR, MPS	19D429763 G8	7.50	750	CC108B	10-06-030	4-1082
Ericsson/G.E.	MPR, MPS	19D429777 G1	7.50	1200	CC107B	10-06-048	4-1043
Ericsson/G.E.	MPR, MPS	19D429777 G12	7.50	1500	CC108C	10-06-060	4-1086
Ericsson/G.E.	MPR, MPS	19D429777 G2	7.50	1200	CC108B	10-06-048	4-1044
Ericsson/G.E.	MPS	19D429777 G9	7.50	1500	CC107B	10-06-060	4-1046
Ericsson/G.E.	MPX	19D429763 G3	7.50	750	CC107A	10-06-030	4-1048
Ericsson/G.E.	MPX	19D429763 G4	7.50	750	CC108B	10-06-030	4-1049
Ericsson/G.E.	MPX	19D429777 G10	7.50	1500	CC107B	10-06-060	4-1143
Ericsson/G.E.	MPX	19D429777 G3	7.50	1200	CC107B	10-06-048	4-1051
Ericsson/G.E.	MPX	19D429777 G4	7.50	1200	CC108B	10-06-048	4-1050
Ericsson/G.E.	Mini	19A148865 P1	7.50	700	CC245X	10-06-028	4-1026
Ericsson/G.E.	Mini II	19A705625 P2	7.50	700	CC101B	10-06-028	4-1027
Ericsson/G.E.	PCS	19A705293 P1	7.50	1200	CC109B	10-06-048	4-1053
Ericsson/G.E.	PCS	19A705293 P2	7.50	1700	CC110C	10-06-068	4-1054
Ericsson/G.E.	PCS	19A705293 P3	7.50	1700	CC110C	10-06-068:0505-06-500-3646	4-1624
Ericsson/G.E.	PE, MPV	19D413522 G1	7.50	500	CC111A	10-06-020	4-1055
Ericsson/G.E.	PE, PY	19D413522 G6	8.75	700	CC112A	10-07-028	4-1056
Ericsson/G.E.	PE, PY, MPV	19D413522 G4	7.50	700	CC111A	10-06-028	4-1058
Ericsson/G.E.	Porta-Mobil II	19D417815 G1	10.00	4000	CA222P	10-08-160	4-1062A
Fujitsu		M98L-1070-0002	6.25	700	CC175C	10-05-028	4-1435
Fujitsu		M98L-1070-0003	6.25	400	CC174B	10-05-016	4-1434
GRID	1660 Notebook Comp	G25-4209	15.00	1450	CC335C	20-12-058	4-1778
Garrett	Metal Detector	NI-5058	7.50	350	CC298A	10-06-014:0205-06-500-3646	4-1695
Gastech Inc.	Gastechtor	49-1571-blue	8.75	3500	CA165X	11-07-140:2929-06-500-3240	4-1065
Gastech Inc.	Gastechtor	49-1571-blue	8.75	3500	CD165X	11-07-140:2929-06-500-3240	4-1065A
Gastech Inc.	Gastechtor	49-1571-blue	8.75	3500	CD219X	10-07-140	4-1065B
Gastech Inc.	Gastechtor	49-1571-potted-black	8.75	4000	CA165X	11-07-160:2525-06-500-3240	4-1067
Gastech Inc.	Gastechtor	49-1571-potted-black	8.75	4000	CD165X	11-07-160:2525-06-500-3240	4-1067A
Gastech Inc.	Gastechtor	49-1571-potted-black	8.75	4500	CA165X	11-07-180:2222-06-500-3240	4-1473
Gastech Inc.	Gastechtor	49-1571-potted-black	8.75	4500	CD165X	11-07-180:2222-06-500-3240	4-1473A
Gastech Inc.	Gastechtor	49-1571-white	8.75	4000	CA165X	11-07-160:2525-06-500-3240	4-1068
Gastech Inc.	Gastechtor	49-1571-white	8.75	4000	CD165X	11-07-160:2525-06-500-3240	4-1068A
Gebetex		L-29	7.50	500	CA236X	11-06-020:1050-06-500-3646	4-1077
General Radio	WR 110		12.50	450	CC162A	10-10-018	4-1078
Geodimeter	Geodimeter	571125272	12.50	6000	CA200X	10-10-240	4-1571
Geodimeter	Geodimeter	571132010	12.50	2000	CA200X	10-10-080	4-1491
Geodimeter	Geodimeter	571132010	12.50	2000	CD200X	10-10-080	4-1491A
Geodimeter	Geodimeter	571143014	12.50	1000	CD201X	10-10-040	4-1492A
H.P.		GL43100	12.00	2500	CA294X	30-06-100	4-1670
H.P.		GL43100	12.00	2500	CD294X	30-06-100	4-1670A

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Henry		TEMPO th-BP4	11.25	800	CC326B	10-09-032	4-1380-02
Henry	FMH44	TEMP BP2	11.25	450	CC163B	10-09-018	4-1095
Hitachi		DP-15	12.50	2000	CA271X	10-10-080:0505-06-500-3646	4-1603
Hitachi		VM-BP65	10.00	2000	CA262P	10-08-080:0505-06-500-3646	4-1629
ICOM		CM-23	8.75	600	CC272B	10-07-024	4-1626
ICOM		CM-7	13.75	425	CC134A	10-11-017	4-1105
ICOM		CM-7G	13.75	500	CC134A	10-11-020	4-1580
ICOM		IC-BP8	8.75	800	CC208B	10-07-032	4-1108
ICOM		IC-CM3	8.75	250	CC133A	10-07-010	4-1102
ICOM		IC-CM5	11.25	425	CC133A	10-09-017	4-1103
ICOM		IC-CM8	8.75	800	CC208B	10-07-032	4-1107
ICOM	H7,H8,U8	CM-80	7.50	600	CC132B	10-06-024	4-1097
ICOM	IC-H18	CM73	13.75	1000	CC133B	10-11-040	4-1101
ICOM	IC-U81T	CM-98	7.50	1400	CC301B	10-06-056:0707-06-500-3646	4-1697
IDO	MINIMO J-51	MT51-UB (L)	6.25	1200	CC282B	10-05-048	4-1640
IDO	MINIMO J-52	MT52-UB (L)	5.00	1200	CC280B	10-04-048:0505-06-500-3646	4-1641
IDO	MINIMO J-53	MT53-UB (L)	6.25	1200	CC281X	10-05-048:0505-06-500-3646	4-1642
IND. SCIENTIFIC	TMX410	1704-1872	7.50	600	CA372X	11-06-024:1010-06-500-3446	4-1797
ISCO	Sampler	60-1684-040	12.50	4000	CA229X	10-10-160	4-1544
Intermec	BarCode Scanner 9440	048106	6.25	1000	CC367C	10-05-040:0707-06-500-3646	4-1828
JABRO	Mobira 500 Cellphone	J/T-8090	7.50	1000	CC197B	10-06-040	4-1615
JVC	Video	NB-G1U	12.50	2200	CC193X	10-10-088	4-1476
Johnson Electro	JCOM P3051	2.29x1.44x2.75H	10.00	600	CC227A	10-08-024	4-1529
KEY	KP80,KP150,KP450	NC-1000	10.00	1000	CC313B	10-08-040	4-1713
KYODO	KG-109-40A/B/C/D/E/F	NC-1000	10.00	1000	CC313B	10-08-040	4-1713-01
Kenwood		KNB 5A	7.50	800	CC137B	10-06-032	4-1628
Kenwood		KNB-9A	7.50	1100	CC312B	10-06-044	4-1704
Kenwood	TH-27-47-28-48-78	PB-13	7.50	700	CC247A	10-06-028	4-1576
Kenwood	TH-27-47-28-48-78	PB-14	12.50	300	CC247A	10-10-012	4-1577
Kenwood	TH-27-47-28-48-78	PB-17	7.50	1100	CC247B	10-06-044	4-1578
Kenwood	TH-27-47-28-48-78	PB-18	12.50	700	CC247A	10-10-028	4-1579
Kenwood	TK 200 (Radio)	KNB 1	11.25	490	CC135A	10-09-020	4-1115
Kenwood	TK 200 (Radio)	KNB 2	11.25	810	CC135B	10-09-032	4-1116
Kenwood	TK 210	KNB 3A	7.50	1000	CC136B	10-06-040	4-1122
Kenwood	TK 210	KNB 4	7.50	1600	CC136C	10-06-064	4-1117
Kenwood	TK 210 (Radio)	KNB 3	7.50	800	CC136A	10-06-032	4-1118
Kenwood	TK 220, TK 320	KNB 5	7.50	600	CC137B	10-06-024	4-1120
Kenwood	TK 220, TK 320	KNB 6	7.50	1100	CC137C	10-06-044	4-1121
Kenwood	TK 220, TK 320	KNB 7	12.50	600	CC137B	10-10-024	4-1119
Kenwood	TK210, TK230	WC-0351-KNB4	7.50	2200	CC136C	10-06-088	4-1484
King Marine Rad	Model 7350	BT-8	12.50	550	CC333B	10-10-022	4-1777
Lexstar	PE, PY, MPV	PR5224	7.50	750	CC111A	10-06-030	4-1058-01
MED.ENG SYSTEMS	PRO-KOOL	8.75V-800mAh	8.75	800	CA305X	11-07-032:6666-06-500-3646	4-1683
MICRO ELECTRONI		NBP-10	11.25	450	CC163B	10-09-018	4-1379-01
Maglite	ML-5000	MA-5	6.25	2200	CA235P	10-05-088:0505-06-500-3646	4-1555
Maglite	ML-5000	MA-5	6.25	2200	CD235P	10-05-088:0505-06-500-3646	4-1555A
Magnavox	Video Camera	AR8359BK01	12.00	2000	CC198C	30-06-080	4-1136

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Magnum Power		MPS-590	12.00	2000	PE352X	30-06-080:1010-500-3646	4-1612
Makita	Power Tools	Battery 7000	7.50	1500	CC237C	10-06-060	4-1546
Makita	Power Tools	Battery 9000	10.00	1500	CC237C	10-08-060	4-1427
Marconi		BP86	11.25	450	CC163B	10-09-018	4-1140
Marconi		DP240	7.50	1200	CC139B	10-06-048	4-1084
Marconi	DP140	B-706	7.50	600	CC139B	10-06-024	4-1458
Marconi	DP140	B-712	7.50	1200	CC139B	10-06-048	4-1459
Marconi	DP15, DP85		15.00	500	CC153A	10-12-020	4-1570
Marconi	DP44, DP45, DP46	DP2, DP41, DP42	12.50	450	CC154A	10-10-018	4-1137
Marconi	DP93	NBB-205	12.50	800	CC140B	10-10-032	4-1635
Marconi	DP94	NBB-204	12.50	450	CC140B	10-10-018	4-1139
Mathews		NSN 6140-01-063-3918	12.50	1800	PE352X	10-10-072	4-1613
Matsushita		EK-P1303ZA	7.50	400	CC341B	10-06-016	4-1781
Matsushita		TZ-910-01	7.50	700	CC202A	10-06-028	4-1493
Maxon		CA-1450A	11.25	500	CC152A	10-09-020:0505-06-500-3646	4-1146
Maxon		TPA-1160	7.50	1100	CC332B	10-06-044:0808-06-500-3646	4-1771
Maxon	CP-1015	CA-1450	11.25	500	CC152A	10-09-020	4-1145
Maxon	SL3400 Series, GSX	CA1145	7.50	500	CC366B	10-06-020	4-1824
Maxon	SL3400 Series, GSX	CA1190	7.50	1000	CC366B	10-06-040	4-1825
Maxon	SP2000	SA-1155	11.25	600	CC269B	10-09-024	4-1616
Maxon	SP2000	SA-1160	11.25	1000	CC269B	10-09-040	4-1617
Metz	MECABLITZ 60CT-1/2	60-39	6.25	1800	CD226P	10-05-072	4-1527
Metz	Photo Flash	45/01.9	7.50	500	CC311X	10-06-020	4-1148
Midland		70-B70	7.50	600	CC259B	10-06-024	4-1720
Midland		70-B77	7.50	1700	CC259C	10-06-068:0505-06-500-3646	4-1589
Midland	70-143	70-B16	10.00	600	CC141B	10-08-024	4-1152
Midland	70-143	70-B21	10.00	1000	CC141B	10-08-040	4-1153
Midland	70-145	70-B30	11.25	450	CC142A	10-09-018	4-1414
Midland	70-145	70-B31-G	11.25	600	CC142A	10-09-024	4-1705
Midland	70-145	70-B32	11.25	1000	CC142B	10-09-040	4-1154
Midland	70-150	70-B08	7.50	800	CC143A	10-06-032	4-1155
Midland	70-150	70-B12	7.50	1200	CC143B	10-06-048	4-1156
Midland	70-154	70-B24	13.75	450	CC133A	10-11-018	4-1157
Midland	70-154	70-B25	8.75	1000	CC133B	10-07-040	4-1159
Midland	70-154	70-B26	13.75	1000	CC133B	10-11-040	4-1158
Midland	70-155	70-B34	7.50	1800	CC144C	10-06-072	4-1415
Midland	70-155, 70-255	70-B17	7.50	450	CC144A	10-06-018	4-1160
Midland	70-155, 70-255	70-B18	7.50	800	CC144A	10-06-032	4-1161
Midland	70-155, 70-255	70-B19	7.50	1200	CC144B	10-06-048	4-1162
Midland	70-165	70-B35	7.50	600	CC145A	10-06-024	4-1163
Midland	70-165	70-B36	7.50	1300	CC145B	10-06-052	4-1164
Midland	70-195	70-B75	7.50	1400	CC259B	10-06-056:0606-06-500-3646	4-1557
Milwaukee Elect	Power Tool	48-11-0080	10.00	1500	CA290P	10-08-060:0610-06-500-3646	4-1665
Mitsubishi		FZ-614	7.50	700	CC340B	10-06-028	4-1780
Mitsubishi		SW-101	7.50	1000	CC339C	10-06-040	4-1779
Mitsubishi	1500	1500 BAT	6.25	1400	CC195B	10-05-056	4-1482
Mitsubishi	3000 Hand-Held		6.25	700	CC178X	10-05-028	4-1452
Mitsubishi	3000 Hand-Held	FZ-976A	6.25	400	CC178X	10-05-016	4-1483
Mitsubishi	3500/4000	FZ-1186A	6.25	360	CC258B	10-05-014	4-1594
Mitsubishi	3500/4000	FZ-1188A	6.25	900	CC258B	10-05-036	4-1660
Mitsubishi	800 Transportable	FZ-809A	10.00	1700	CC194C	10-08-068	4-1481
Mitsubishi	900 Hand-Held	900-BAT	7.50	700	CC101B	10-06-028	4-1513
Mitsubishi	900 Hand-Held	FZ-755A	7.50	700	CC101B	10-06-028	4-1165
Mobira	500 Series	BTH-5	7.50	1000	CC197B	10-06-040	4-1166
Mobira	Cityman 100		7.50	700	CC179B	10-06-028	4-1454
Mobira	Cityman 450	UL61	10.00	1000	CC180B	10-08-040	4-1453

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Motorola Cell		SNN-4002A	12.00	4000	CA221X	30-06-160	4-1526
Motorola Cell		SNN-4002A	12.00	4000	CD221X	30-06-160	4-1526A
Motorola Cell		SNN-4229A	7.50	0	CA124C	10-06-000	4-1664
Motorola Cell	9800 XL	SNN-4040A	7.50	1300	CC125B	10-06-052	4-1168
Motorola Cell	9800 XL	SNN-4040A	7.50	1300	CA124C	10-06-052:0606-06-500-3646	4-1168A
Motorola Cell	9800 XL	SNN-4043A	7.50	725	CC124B	10-06-029	4-1167
Motorola Cell	9800 XL	SNN-4043A	7.50	725	CA124C	10-06-029	4-1167A
Motorola Cell	9800 XL	SNN-4043A	7.50	725	CD124B	10-06-029	4-1167B
Motorola Cell	Dyna TAC	SNN-4...all Dyna TAC	7.50	0	PE124C		4-1438B
Motorola Cell	Dyna TAC	SNN-4009A	7.50	1300	CC125B	10-06-052	4-1421
Motorola Cell	Dyna TAC	SNN-4009A	7.50	1300	CA124C	10-06-052	4-1421A
Motorola Cell	Dyna TAC	SNN-4011A	7.50	1300	CC125B	10-06-052	4-1172
Motorola Cell	Dyna TAC	SNN-4011A	7.50	1300	CA124C	10-06-052	4-1172A
Motorola Cell	Dyna TAC	SNN-4014A	7.50	850	CC125B	10-06-034	4-1170
Motorola Cell	Dyna TAC	SNN-4014A	7.50	850	CA124C	10-06-034	4-1170A
Motorola Cell	Dyna TAC	SNN-4014A	7.50	850	CD124B	10-06-034	4-1170B
Motorola Cell	Dyna TAC	SNN-4015A	7.50	1000	CA124C	10-06-040	4-1171
Motorola Cell	Dyna TAC	SNN-4016A	7.50	1300	CC125B	10-06-052	4-1175
Motorola Cell	Dyna TAC	SNN-4016A	7.50	1300	CA124C	10-06-052	4-1175A
Motorola Cell	Dyna TAC	SNN-4023A	7.50	3000	CA124C	10-06-120	4-1437
Motorola Cell	Dyna TAC	SNN-4024A	7.50	2600	CA124C	10-06-104	4-1465
Motorola Cell	Dyna TAC	SNN-4025A	7.50	3000	CA124C	10-06-120	4-1174
Motorola Cell	Dyna TAC	SNN-4025A	7.50	3000	CA124C	10-06-120	4-1438
Motorola Cell	Dyna TAC	SNN-4025A	7.50	3000	CD124C	10-06-120	4-1438A
Motorola Cell	Dyna TAC	SNN-4038A	7.50	1500	CC125B	10-06-060:0606-06-500-3646	4-1422
Motorola Cell	Dyna TAC	SNN-4038A	7.50	1500	CA124C	10-06-060:0606-06-500-3646	4-1422A
Motorola Cell	Dyna TAC	SNN-4039A	7.50	1300	CC125B	10-06-052	4-1295
Motorola Cell	Dyna TAC	SNN-4039A	7.50	1300	CA124C	10-06-052	4-1295A
Motorola Cell	Dyna TAC	SNN-4039A	7.50	1300	CD124B	10-06-052	4-1295B
Motorola Cell	Dyna TAC	SNN-4040B	7.50	1500	CC125B	10-06-060	4-1173
Motorola Cell	Dyna TAC	SNN-4040B	7.50	1500	CA124C	10-06-060	4-1173A
Motorola Cell	Dyna TAC	SNN-4041A	7.50	725	CC124B	10-06-029	4-1169
Motorola Cell	Dyna TAC	SNN-4041A	7.50	725	CA124C	10-06-029	4-1169A
Motorola Cell	Dyna TAC	SNN-4114A	7.50	1400	CA124C	10-06-056	4-1723
Motorola Cell	Dyna TAC	SNN-4115A	7.50	1500	CA124C	10-06-060	4-1687
Motorola Cell	Dyna TAC	SNN-4211A	7.50	1000	CA124C	10-06-040	4-1596
Motorola Cell	Dyna TAC	SNN-4212A	7.50	1100	CA124C	10-06-044	4-1841
Motorola Cell	Dyna TAC	SNN-4214A	7.50	1500	CA124C	10-06-060	4-1622
Motorola Cell	Dyna TAC	TNN-6000A (1300)	7.50	1300	CA124C	10-06-052	4-1643
Motorola Cell	Dyna TAC	TNN-6000B (1000)	7.50	1000	CA124C	10-06-040:0606-06-500-3646	4-1645
Motorola Cell	Dyna TAC	TNN-6000B (850)	7.50	850	CA124C	10-06-034	4-1644
Motorola Cell	Dyna TAC	TNN-6000C (1000)	7.50	1000	CA124C	10-06-040:0606-06-500-3646	4-1646
Motorola Cell	DynaTAC	SNN-4213A	7.50	700	CA124C	10-06-028	4-1749
Motorola Cell	FLIP PHONE	SNN-4019C	6.25	700	CC126C	10-05-028	4-1837
Motorola Cell	Filp Phone	SNN-4150B	6.25	1050	CC126C	10-05-042	4-1831
Motorola Cell	Flip Phone	SNN-4006A	6.25	1000	CC126C	10-05-040	4-1830
Motorola Cell	Flip Phone	SNN-4008A	6.25	360	CC126C	10-05-014	4-1185
Motorola Cell	Flip Phone	SNN-4008B	6.25	360	CC126C	10-05-014	4-1423
Motorola Cell	Flip Phone	SNN-4018A	6.25	360	CC126C	10-05-014	4-1187
Motorola Cell	Flip Phone	SNN-4018B	6.25	450	CC126C	10-05-018	4-1487
Motorola Cell	Flip Phone	SNN-4019A	6.25	700	CC126C	10-05-028	4-1188
Motorola Cell	Flip Phone	SNN-4019B	6.25	900	CC126C	10-05-036	4-1585
Motorola Cell	Flip Phone	SNN-4020A	6.25	700	CC126C	10-05-028	4-1190
Motorola Cell	Flip Phone	SNN-4020B	6.25	700	CC126C	10-05-028	4-1688
Motorola Cell	Flip Phone	SNN-4026A	6.25	360	CC126C	10-05-014	4-1186
Motorola Cell	Flip Phone	SNN-4027A	6.25	700	CC126C	10-05-028	4-1189
Motorola Cell	Flip Phone	SNN-4042A	6.25	700	CC126C	10-05-028	4-1619
Motorola Cell	Flip Phone	SNN-4057A	6.25	1050	CC126C	10-05-042	4-1191
Motorola Cell	Flip Phone	SNN-4057B	6.25	1100	CC126C	10-05-044	4-1649
Motorola Cell	Flip Phone	SNN-4057C	6.25	900	CC126C	10-05-036	4-1583
Motorola Cell	Flip Phone	SNN-4057D	6.25	1050	CC126C	10-05-042	4-1812
Motorola Cell	Flip Phone	SNN-4058A	6.25	1050	CC126C	10-05-042	4-1192
Motorola Cell	Flip Phone	SNN-4058A	6.25	1050	CD126B	10-05-042	4-1192A
Motorola Cell	Flip Phone	SNN-4058B	6.25	1050	CC126C	10-05-042	4-1412
Motorola Cell	Flip Phone	SNN-4059B	6.25	1300	CC126C	10-05-052	4-1488
Motorola Cell	Flip Phone	SNN-4102A	6.25	500	CC126C	10-05-020	4-1525

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE	ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Motorola Cell	Flip Phone	SNN-4104		6.25	600	CC126C	10-05-024	4-1575
Motorola Cell	Flip Phone	SNN-4131A		6.25	360	CC126C	10-05-014	4-1562
Motorola Cell	Flip Phone	SNN-4131C		6.25	360	CC126C	10-05-014	4-1590
Motorola Cell	Flip Phone	SNN-4133A		6.25	400	CC126C	10-05-016	4-1620
Motorola Cell	Flip Phone	SNN-4147A		6.25	400	CC126C	10-05-016	4-1621
Motorola Cell	Flip Phone	SNN-4148B		6.25	550	CC126C	10-05-022	4-1722
Motorola Cell	Flip Phone	SNN-4149A		6.25	700	CC126C	10-05-028	4-1656
Motorola Cell	Flip Phone	SNN-4149B		6.25	700	CC126C	10-05-028	4-1827
Motorola Cell	Flip Phone	SNN-4150A		6.25	1000	CC126C	10-05-040:0606-06-500-3646	4-1647
Motorola Cell	Flip Phone	SNN-4180A		6.25	360	CC126C	10-05-014	4-1574
Motorola Cell	Flip Phone	SNN-4181A		6.25	400	CC126C	10-05-016	4-1657
Motorola Cell	Flip Phone	SNN-4182A		6.25	1000	CC126C	10-05-040	4-1672
Motorola Cell	Flip Phone	SNN-4184A		6.25	400	CC126C	10-05-016	4-1673
Motorola Cell	Flip Phone	SNN-4203A		6.25	900	CC126C	20-05-036	4-1724
Motorola Cell	Flip Phone	SNN-4203B		6.25	900	CC126C	20-05-036	4-1819
Motorola Cell	Flip Phone	SNN-4204A		6.25	900	CC126C	20-05-036	4-1725
Motorola Cell	Flip Phone	SNN-4205A		6.25	900	CC126C	20-05-036	4-1726
Motorola Cell	Flip Phone	SNN-4206A		6.25	900	CC126C	20-05-036	4-1727
Motorola Cell	Flip Phone	SNN-4238		6.25	500	CC126C	20-05-020	4-1728
Motorola Cell	Flip Phone	SNN-4239A		6.25	500	CC126C	20-05-020	4-1676
Motorola Cell	Flip Phone	SNN-4239B		6.25	500	CC126C	20-05-020	4-1821
Motorola Cell	Flip Phone	SNN-4241		6.25	500	CC126C	20-05-020	4-1729
Motorola Cell	Flip Phone	SNN-4246		6.25	300	CC126C	20-05-012	4-1730
Motorola Cell	Flip Phone	SNN-4247A		6.25	350	CC126C	20-05-014	4-1675
Motorola Cell	Flip Phone	SNN-4249A		6.25	300	CC126C	20-05-012	4-1731
Motorola Cell	Flip Phone	SNN-4258A		6.25	1000	CC126C	20-05-040	4-1732
Motorola Cell	Flip Phone	SNN-4259A		6.25	1350	CC126C	20-05-054	4-1677
Motorola Cell	Flip Phone	SNN-4260		6.25	1000	CC126C	20-05-040	4-1733
Motorola Cell	Flip Phone	SNN-4261		6.25	1000	CC126C	20-05-040	4-1734
Motorola Cell	Flip Phone	SNN-4373A		6.25	1300	CC126C	20-05-052	4-1832
Motorola Cell	Flip Phone	SNN-4378A		6.25	1350	CC126C	20-05-054	4-1833
Motorola Cell	Talk PAK phone	SNN-4010B		7.50	1300	CC125B	10-06-052	4-1294
Motorola Cell	Talk PAK phone	SNN-4010B		7.50	1300	CA124C	10-06-052:0606-06-500-3646	4-1294A
Motorola Cell	Toughtalker Series	SNN-4139A		12.00	2300	CC198C	30-06-092	4-1769
Motorola Comm		NTN-7146A		7.50	1200	CC260B	10-06-048:0808-06-500-3646	4-1634
Motorola Comm		NTN-7146A		7.50	1200	CA240P	10-06-048:0808-06-500-3646	4-1634A
Motorola Comm		SNN-4067A		12.00	2300	CC198C	30-06-092	4-1686
Motorola Comm	Expo	NLN-7161A		7.50	250	CC113A	10-06-010	4-1178
Motorola Comm	Expo	NLN-7162A		7.50	500	CC113A	10-06-020	4-1180
Motorola Comm	Expo	NLN-7279B		7.50	500	CC113A	10-06-020	4-1181
Motorola Comm	GP300	HNN-8133A		7.50	1100	CC188C	11-06-044:6464-06-500-3646	4-1818
Motorola Comm	GP300	HNN-8133B		7.50	1100	CC188C	11-06-044:6464-06-500-3646	4-1694
Motorola Comm	GP300	HNN-9628A		7.50	1100	CC188C	11-06-044:6464-06-500-3646	4-1467
Motorola Comm	GP300	HNN-9628A		7.50	1100	CC188C	11-06-044:6464-06-500-3646	4-1467A
Motorola Comm	GP300	HNN-9701A		7.50	1100	CC188C	11-06-044:6464-06-500-3646	4-1472
Motorola Comm	GP300	HNN-9808A		7.50	530	CC238B	10-06-021	4-1471
Motorola Comm	GP300	HNN-9987A		7.50	1000	CC188C	11-06-040:7070-06-500-3646	4-1606
Motorola Comm	HT1000	NTN-7143C		7.50	1200	CC260B	10-06-048:0808-06-500-3646	4-1595
Motorola Comm	HT1000	NTN-7143C		7.50	1200	CA240P	10-06-048:0808-06-500-3646	4-1595A
Motorola Comm	HT1000	NTN-7372A		7.50	1300	CC240B	10-06-052:0808-06-500-3646	4-1690
Motorola Comm	HT1000	NTN-7372A		7.50	1300	CA240P	10-06-052:0808-06-500-3646	4-1690A
Motorola Comm	HT1000, MT2000	NTN-7144A	(1350)	7.50	1350	CC240B	10-06-054:0808-06-500-3646	4-1648
Motorola Comm	HT1000, MT2000	NTN-7144A	(1350)	7.50	1350	CA240P	10-06-054:0808-06-500-3646	4-1648A
Motorola Comm	HT1000, MT2000	NTN-7144A	(1500)	7.50	1500	CC240B	10-06-060:0707-06-500-3646	4-1556
Motorola Comm	HT1000, MT2000	NTN-7144A	(1500)	7.50	1500	CA240P	10-06-060:0707-06-500-3646	4-1556A
Motorola Comm	HT1000, MT2000	NTN-7147A		7.50	1500	CC240B	10-06-060:0707-06-500-3646	4-1671
Motorola Comm	HT1000, MT2000	NTN-7147A		7.50	1500	CA240P	10-06-060:0707-06-500-3646	4-1671A
Motorola Comm	HT1000, MT2000	NTN-7149B		7.50	1400	CA240P	10-06-056:0606-06-500-3646	4-1718
Motorola Comm	HT1000, MTS2000	NTN-7341A		7.50	1500	CA240P	10-06-060	4-1750
Motorola Comm	HT220	NLN-6682A		15.00	225	CC115A	10-12-009	4-1197
Motorola Comm	HT220	NLN-6761A		15.00	450	CC114A	10-12-018	4-1199
Motorola Comm	HT220	NLN-6899A		15.00	225	CC115A	10-12-009	4-1198
Motorola Comm	HT220	NLN-6900A		15.00	450	CC114A	10-12-018	4-1200
Motorola Comm	HT220	NLN-6900B		15.00	500	CC114A	10-12-020	4-1201
Motorola Comm	HT440	NLN-7401A		12.50	500	CC116C	10-10-020	4-1202

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE	ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Motorola Comm	HT440	NLN-7640A		12.50	600	CC116C	10-10-024	4-1205
Motorola Comm	HT440	NLN-7654A		12.50	0	CC116C	10-10-000	4-1693
Motorola Comm	HT440	NLN-7694A		12.50	500	CC116C	10-10-020	4-1204
Motorola Comm	HT50	NTN-5453A		10.00	1000	CC116C	10-08-040	4-1208
Motorola Comm	HT600	NTN-4585A		10.00	900	CC117A	10-08-036	4-1210
Motorola Comm	HT600	NTN-4588A		10.00	900	CC117A	10-08-036	4-1212
Motorola Comm	HT600	NTN-5048A		10.00	900	CC117A	10-08-036	4-1213
Motorola Comm	HT600	NTN-7016A		10.00	950	CC117B	20-08-038	4-1772
Motorola Comm	HT600, HT800	NTN-4563A		10.00	600	CC117A	10-08-024	4-1214
Motorola Comm	HT600, HT800	NTN-4584A		10.00	600	CC117A	10-08-024	4-1215
Motorola Comm	HT600, HT800	NTN-5414A		10.00	1000	CC117B	10-08-040	4-1218
Motorola Comm	HT600, HT800	NTN-5414B		10.00	1000	CC117B	10-08-040	4-1219
Motorola Comm	HT600, HT800	NTN-5415A		10.00	1000	CC117B	10-08-040	4-1217
Motorola Comm	HT600; HT800	NTN-5415B		10.00	1000	CC117B	10-08-040	4-1220
Motorola Comm	HT800	NTN-5047A		10.00	600	CC117A	10-08-024	4-1221
Motorola Comm	HT90	NLN-7434A		12.50	450	CC116C	10-10-018	4-1222
Motorola Comm	HT90	NLN-7435A		12.50	450	CC116C	10-10-018	4-1223
Motorola Comm	HT90	NTN-4313A		12.50	600	CC116C	10-10-024	4-1224
Motorola Comm	Handiecom, MH70	NLN-8002A		12.50	500	CC131A	10-10-020	4-1194
Motorola Comm	Handiecom, MH70	NLN-8096A		12.50	500	CC131A	10-10-020	4-1195
Motorola Comm	KDT	NLN-9905A		7.50	500	CC360B	10-06-020:0707-06-500-3646	4-1225
Motorola Comm	KDT	NTN-4994A		7.50	500	CC360B	10-06-020:0707-06-500-3646	4-1226
Motorola Comm	KDT	NTN-4994B		7.50	500	CC360B	10-06-020:0707-06-500-3646	4-1798
Motorola Comm	MT1000	NTN-4823A		10.00	600	CC117A	10-08-024	4-1227
Motorola Comm	MT1000	NTN-4824A		10.00	900	CC117A	10-08-036	4-1229
Motorola Comm	MT1000	NTN-4868A		10.00	600	CC117A	10-08-024	4-1228
Motorola Comm	MT1000	NTN-4869A		10.00	1000	CC117B	10-08-040	4-1232
Motorola Comm	MT1000	NTN-5161A		10.00	500	CC117A	10-08-020:0505-06-500-3646	4-1448
Motorola Comm	MT1000	NTN-5447A		10.00	1000	CC117B	10-08-040	4-1231
Motorola Comm	MT1000	NTN-5447B	(1000)	10.00	1000	CC117B	10-08-040	4-1426
Motorola Comm	MT1000	NTN-5447B	(1100)	10.00	1100	CC117B	10-08-044	4-1426-01
Motorola Comm	MT1000	NTN-5448A		10.00	1000	CC117B	10-08-040	4-1230
Motorola Comm	MT1000	NTN-5448B		10.00	1000	CC117B	10-08-040	4-1446
Motorola Comm	MT1000, HT600	NTN-4825A		10.00	900	CC117A	10-08-036	4-1233
Motorola Comm	MT1000, MTX800	NTN-4822A		10.00	600	CC117A	10-08-024	4-1240
Motorola Comm	MT500, HT220	NLN-4462B		15.00	250	CC115A	10-12-010	4-1234
Motorola Comm	MT500, MT600	NLN-8232A		15.00	450	CC114A	11-12-018:5040-06-500-3546	4-1235
Motorola Comm	MT500, MT700	NLN-4462A		15.00	275	CC115A	10-12-011	4-1236
Motorola Comm	MT500, MT700	NLN-4463A		15.00	500	CC114A	10-12-020	4-1239
Motorola Comm	MT500, MT700	NLN-4463B		15.00	500	CC114A	10-12-020	4-1238
Motorola Comm	MT500, MT700	NLN-8232B		15.00	450	CC114A	11-12-018:5040-06-500-3546	4-1237
Motorola Comm	MX300,-S,-T	NLN-4002A		7.50	500	CC118A	10-06-020	4-1241
Motorola Comm	MX300,-S,-T	NLN-4002B		7.50	500	CC118A	10-06-020	4-1242
Motorola Comm	MX300,-S,-T	NLN-4891B		7.50	1250	CC119C	10-06-050	4-1248
Motorola Comm	MX300,-S,-T	NLN-4891C		7.50	1250	CC119C	10-06-050	4-1250
Motorola Comm	MX300,-S,-T	NLN-5320A		7.50	2000	CC118C	10-06-080	4-1255
Motorola Comm	MX300,-S,-T	NLN-5320B		7.50	2000	CC118C	10-06-080	4-1254
Motorola Comm	MX300,-S,-T	NLN-5320C		7.50	2250	CC118C	10-06-090	4-1256
Motorola Comm	MX300,-S,-T	NLN-5320C		7.50	2600	CC118C	10-06-104	4-1257
Motorola Comm	MX300,-S,-T	NLN-5320D		7.50	2800	CC118C	10-06-112	4-1258
Motorola Comm	MX300,-S,-T	NLN-5860B		7.50	1250	CC118B	10-06-050	4-1249
Motorola Comm	MX300,-S,-T	NLN-5860C		7.50	1400	CC118B	10-06-056	4-1252
Motorola Comm	MX300,-S,-T	NLN-5860D		7.50	1400	CC118B	10-06-056	4-1689
Motorola Comm	MX300,-S,-T	NLN-8834B		7.50	700	CC118A	10-06-028	4-1243
Motorola Comm	MX300,-S,-T	NLN-8834C	(1100)	7.50	1100	CC118B	10-06-044	4-1246-01
Motorola Comm	MX300,-S,-T	NLN-8834C	(700)	7.50	700	CC118A	10-06-028	4-1246
Motorola Comm	MX300,-S,-T	NLN-8835B		7.50	1250	CC118B	10-06-050	4-1251
Motorola Comm	MX300,-S,-T	NLN-9998C	(1300)	7.50	1300	CC118B	10-06-052	4-1636
Motorola Comm	MX300R	NLN-9726C	(1250)	7.50	1250	CC128C	10-06-050	4-1259
Motorola Comm	MX300R	NLN-9726C	(1400)	7.50	1400	CC128C	10-06-056	4-1260
Motorola Comm	P10,-50,-60, HT10	HNN-9027A		11.25	580	CC129A	10-09-023	4-1262
Motorola Comm	P100, P200	NTN-5545B		10.00	1100	CC117B	10-08-044	4-1820
Motorola Comm	P100, P200, P210	NTN-5545A		10.00	1000	CC117B	10-08-040	4-1265
Motorola Comm	P200, P210	NTN-5531A		10.00	600	CC117A	10-08-024	4-1263
Motorola Comm	R8's	NTN-7762A		7.50	1200	CC361C	10-06-048:0707-06-500-3646	4-1807
Motorola Comm	Radius P100	NTN-4817B		10.00	650	CC116C	10-08-026	4-1269

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Motorola Comm	Radius P100	NTN-4818B	10.00	650	CC116C	10-08-026	4-1268
Motorola Comm	Radius P100	NTN-5451A	10.00	1000	CC116C	10-08-040	4-1270
Motorola Comm	Radius P110	HNN-8148A	7.50	1200	CC188C	10-06-048:0606-06-500-3646	4-1593
Motorola Comm	Radius P200	NTN-5521A	10.00	900	CC117A	10-08-036	4-1271
Motorola Comm	Radius P200	NTN-5521B	10.00	1000	CC117B	10-08-040	4-1272
Motorola Comm	Radius P50	HNN-9044A	7.50	500	CC129A	10-06-020	4-1273
Motorola Comm	STX	NTN-4326A	7.50	850	CC122A	10-06-034	4-1288
Motorola Comm	STX	NTN-4326B	7.50	1300	CC122B	10-06-052	4-1538
Motorola Comm	STX	NTN-4327A	7.50	1250	CC122B	10-06-050	4-1290
Motorola Comm	STX	NTN-4327B	7.50	1800	CC122C	10-06-072	4-1292
Motorola Comm	STX	NTN-4327B	7.50	1800	CC122C	10-06-072:0707-06-500-3646	4-1292A
Motorola Comm	STX	NTN-4327C	7.50	1500	CC122C	10-06-060	4-1692
Motorola Comm	STX	NTN-4500A	7.50	1250	CC122B	10-06-050	4-1291
Motorola Comm	STX	NTN-4518A	7.50	1800	CC123C	10-06-072	4-1293
Motorola Comm	STX	NTN-4534A	7.50	900	CC122B	10-06-036	4-1289
Motorola Comm	Saber	NTN-4592C	7.50	500	CC196A	10-06-020	4-1485
Motorola Comm	Saber	NTN-4595B	7.50	1800	CC120C	10-06-072	4-1274
Motorola Comm	Saber	NTN-4595C	7.50	1800	CC120C	10-06-072	4-1275
Motorola Comm	Saber	NTN-4595C	7.50	1800	CC120C	10-06-072:0707-06-500-3646	4-1275A
Motorola Comm	Saber	NTN-4596C	7.50	1800	CC120C	10-06-072:0505-06-500-3646	4-1539
Motorola Comm	Saber R	NTN-7058A	7.50	1500	CC270C	10-06-060	4-1540
Motorola Comm	Saber, MX1000	NTN-4592A	7.50	500	CC120A	10-06-020	4-1276
Motorola Comm	Saber, MX1000	NTN-4593A	7.50	900	CC120A	10-06-036	4-1280
Motorola Comm	Saber, MX1000	NTN-4593B	7.50	1000	CC120B	10-06-040	4-1284
Motorola Comm	Saber, MX1000	NTN-4593C	7.50	1100	CC120B	10-06-044:1010-06-600-3646	4-1573
Motorola Comm	Saber, MX1000	NTN-4593C	7.50	1100	CC120B	10-06-044:0707-06-500-3646	4-1573A
Motorola Comm	Saber, MX1000	NTN-4595A	7.50	1500	CC120C	10-06-060	4-1285
Motorola Comm	Saber, MX1000	NTN-4596A	7.50	1800	CC120C	10-06-072:0505-06-500-3646	4-1286
Motorola Comm	Saber, MX1000	NTN-4657A	7.50	1000	CC120B	10-06-040	4-1281
Motorola Comm	Saber, MX1000	NTN-4671A	7.50	1000	CC306C	10-06-040:0707-06-500-3646	4-1283
Motorola Comm	Saber, MX1000	NTN-4992A	7.50	1800	CC120C	10-06-072	4-1287
Motorola Comm	Saber, MX1000	NTN-5155A	7.50	900	CC121B	10-06-036:1010-06-500-3666	4-1279
Motorola Comm	Saber, MX1000	NTN-5155A	7.50	900	CC306C	10-06-036:1010-06-500-3666	4-1279A
Motorola Comm	VISAR	NTN-7394A	7.50	1500	CC318C	20-06-060	4-1712
Motorola Comm	VISAR	NTN-7395A	7.50	1200	CC318C	10-06-048	4-1806
Motorola Comm	VISAR	NTN-7396A (AP)	7.50	600	CC318C	20-06-024	4-1809
NAME NOT KNOWN		Same as"KEY NC-1000"	10.00	1100	CC313B	10-08-044	4-1713-02
NEC	P300, P200	MPS-B-2066	6.25	700	CC172A	10-05-028	4-1419
NEC	P401, P601	MPS-B-2089	6.25	700	CC228C	10-05-028	4-1543
NEC	P601	MPS-B-2088	6.25	400	CC228C	10-05-016:0909-06-500-3646	4-1542
NEC	P9000, 9A, 9C	MPS-B-2039	7.50	900	CC167A	10-06-036	4-1298
NEC	P9000, 9A, 9C	MPS-B-2044	7.50	900	CC167A	10-06-036	4-1428
NEC America	P120	155-0316	6.25	700	CC336X	10-05-028	4-1767
NEC America	P120	155-0320	6.25	1200	CC337X	10-05-048	4-1768
NEC Corporation	P100	MPS-B-2123	6.25	700	CC336X	10-05-028	4-1767-01
NIPPON IDOH TSU	MINIMO	MT30-UA(S)	6.25	360	CC224C	10-05-014	4-1530
NIPPON IDOH TSU	MINIMO	MT30-UB(L)	6.25	600	CC224C	10-05-024	4-1531
NMP	Nokia 101	BTH-2HE	7.50	1100	CC218C	20-06-044	4-1678-01
NMP	Nokia 101	BTH-2HU	7.50	1100	CC218C	20-06-044	4-1678-02
NMP	Nokia 101	BTH-2LT	7.50	380	CC218C	10-06-015	4-1754
NTT / Do Co Mo	MO-VA D	TZ-804 D (L) 1200	6.25	1200	CC268X	10-05-048	4-1610
NTT / Do Co Mo	MO-VA D	TZ-804 D (L) 600	6.25	600	CC212X	10-05-024	4-1517
NTT / Do Co Mo	MO-VA D	TZ-804 D (S)	6.25	400	CC244X	10-05-016	4-1563
NTT / Do Co Mo	MO-VA D II	TZ-805 M1 D	3.75	850	CC353C	20-03-034	4-1793
NTT / Do Co Mo	MO-VA F	TZ-804 F (L) 1200	6.25	1200	CC213X	10-05-048	4-1604
NTT / Do Co Mo	MO-VA F	TZ-804 F (L) 700	6.25	700	CC213X	10-05-028	4-1518
NTT / Do Co Mo	MO-VA F	TZ-804 F (L) 700	6.25	700	CD213B	10-05-028	4-1518A
NTT / Do Co Mo	MO-VA F	TZ-804 F (S) (400)	6.25	400	CC213X	10-05-016	4-1564
NTT / Do Co Mo	MO-VA F	TZ-804 F (S) 500	6.25	500	CC213X	20-05-020	4-1605

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
NTT / Do Co Mo	MO-VA F II	TZ-805 S1 F	3.75	630	CC354X	10-03-025:0202-06-500-3646	4-1794
NTT / Do Co Mo	MO-VA N	TZ-804 N (L) 700	6.25	700	CC214B	10-05-028	4-1519
NTT / Do Co Mo	MO-VA N	TZ-804 N (L) 900	6.25	900	CC214B	10-05-036	4-1611
NTT / Do Co Mo	MO-VA N	TZ-804 N (M)	6.25	540	CC243B	10-05-022	4-1565
NTT / Do Co Mo	MO-VA N II	TZ-805 S1 N	5.00	950	CC355X	20-04-038	4-1795
NTT / Do Co Mo	MO-VA P	TZ-804 P (L)	5.00	1200	CC242C	10-04-048	4-1520
NTT / Do Co Mo	MO-VA P	TZ-804 P (S)	5.00	500	CC242C	21-04-020	4-1532
NTT / Do Co Mo	MO-VA P II	TZ-805 M1 P	3.75	1400	CC356C	10-03-056:0707-06-500-3646	4-1796
NTT / Do Co Mo	Digital MO-VA F	TZ-820B F (L1)	6.25	1200	CC283X	10-05-048	4-1651
NTT / Do Co Mo	Digital MO-VA F	TZ-820B F (S1)	6.25	500	CC283X	20-05-020	4-1650
NTT / Do Co Mo	Digital MO-VA N	TZ-820B N (L1)	6.25	1200	CC285C	10-05-048	4-1653
NTT / Do Co Mo	Digital MO-VA N	TZ-820B N (S1)	6.25	500	CC285C	20-05-020	4-1652
NTT / Do Co Mo	Digital MO-VA P	TZ-820B P (L1)	6.25	1200	CC287B	10-05-048	4-1655
NTT / Do Co Mo	Digital MO-VA P	TZ-820B P (S1)	6.25	500	CC286B	20-05-020	4-1654
NTT / Do Co Mo	MO-VA R	TZ-804 1R (L)	5.00	1200	CC279B	10-04-048	4-1639
NTT / Do Co Mo	MO-VA R	TZ-804 1R (S)	5.00	500	CC279B	10-04-020	4-1638
Neotronics	Exotox	325-0346-00	5.00	2000	CA246P	11-04-080:1515-06-500-3340	4-1566
Neotronics	NEOTEC	w/o ID	11.25	500	CC142A	10-09-020	4-1414-01
NiCd Cells		1 AA cell (450)	1.25	450	CA303X	10-01-018	4-1305
NiCd Cells		1 AA cell (600)	1.25	600	CA303X	10-01-024	4-1305-01
NiCd Cells		1 C cell (1800)	1.25	1800	CA304X	10-01-072	4-1308
NiCd Cells		1 C cell (2000)	1.25	2000	CA304X	10-01-080	4-1308-01
NiCd Cells		1 D cell (3500)	1.25	3500	CA236X	10-01-140	4-1311
NiCd Cells		1 D cell (4000)	1.25	4000	CA236X	10-01-160	4-1311-01
NiCd Cells		6 AA cells (500)	7.50	500	CD207P	10-06-020	4-1502
NiCd Cells		6 AA cells (500)	7.50	500	CA207P	10-06-020	4-1502A
NiCd Cells		6 AA cells (600)	7.50	600	CD207P	10-06-024	4-1502-01
NiCd Cells		AAA Cell	1.25	220	CA302X	10-01-009	4-1698
NiCd Cells	H.H.C.	3 C Cell Pack (2000)	3.75	2000	CA308P	10-03-080	4-1706
NiCd Cells	Pro Video Camcorder		13.75	1650	CA273X	10-11-066:0707-06-500-3646	4-1810
NiCd Cells	Sony	6xN-550AA shrink pk	7.50	600	CA291X	10-06-024	4-1666
NiCd Cells SAFT		1 VR 4D	1.25	4000	CA236X	11-01-160:5050-06-500-5646	4-1317
Nokia		BBH-7S	7.50	800	CC319C	10-06-032	4-1747
Nokia		BTH-3	7.50	750	CC179B	10-06-030	4-1553
Nokia		BTH-4	7.50	1000	CC179B	20-06-040:1010-26-500-3646	4-1554
Nokia	Cityman Cellphone	UL61	10.00	1000	CC180B	10-08-040	4-1456
Nokia	NOKIA	BBM-5H	11.25	1700	CA364P	10-09-068:0606-06-500-3646	4-1814
Nokia	NOKIA	BBM-5H	11.25	1700	CA364P	10-09-068	4-1814-01
Nokia	NOKIA	BBM-5L	11.25	1100	CA364P	10-09-044:0707-06-500-3646	4-1813
Nokia	NOKIA 250,NOKIA 2020	BBH-8H	6.25	1100	CC331C	20-05-044	4-1816
Nokia	NOKIA 250,NOKIA 2020	BBH-9H	6.25	500	CC331C	20-05-020	4-1815
Nokia	Nokia 101	BTH-2H	7.50	1000	CC218C	20-06-040	4-1678
Nokia	Nokia 101	BTH-2L	7.50	380	CC218C	10-06-015	4-1679
Nokia	Nokia 101	BTH-2LU	7.50	380	CC218C	10-06-015	4-1521
Nokia	Nokia 101	BTH-2SU	7.50	800	CC218C	10-06-032	4-1522
Nokia	Nokia 1011	BTH-7H	7.50	1700	CC278C	10-06-068:0606-06-500-3646	4-1783
Nokia	Nokia 1011	BTH-7M	7.50	1100	CC278C	20-06-044	4-1784
Nokia	Nokia 1011	BTH-7S	7.50	900	CC278C	10-06-036	4-1637
Nokia	Nokia 2120	BBH-1H	6.25	1500	CC331C	10-05-060	4-1766
Nokia	Nokia 2120	BBH-1S	6.25	500	CC331C	10-05-020	4-1764
Nokia	Nokia 2120	BBH-2H	6.25	1100	CC331C	10-05-044	4-1765
Nokia	Nokia 2120	BBH-2S	6.25	400	CC331C	10-05-016	4-1763
Nokia	Nokia 232	BTH-8H	6.25	800	CC338X	10-05-032	4-1761
Nokia	Nokia 232	BTH-8HM	6.25	1100	CC338X	10-05-044	4-1762
Nokia	Nokia 232	BTH-8S	6.25	380	CC330X	10-05-015	4-1759
Nokia	Nokia 232	BTH-8SM	6.25	550	CC330X	10-05-022	4-1760
Nokia	Nokia 250,Nokia 2020	BBH-8S	6.25	700	CC331C	10-05-028	4-1829
Nokia	Nokia 900		7.50	700	CC179B	10-06-028	4-1455
Nokia	P-30	P-30-BP	7.50	1000	CC146B	10-06-040	4-1320
Nokia	P4000, PT 612	P1BP	7.50	700	CC189A	10-06-028	4-1321

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE	ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
NovaTel	Avante 6030	40115057		12.50	1400	CA350C	11-10-056:5050-06-500-3646	4-1791
NovaTel	PTR 800	40114491		7.50	1000	CC183B	10-06-040	4-1323
NovaTel	PTR-850,Avante7000	40115053		6.25	600	CC349C	10-05-024:0202-06-500-3646	4-1789
NovaTel	PTR-850,Avante7000	40115054		6.25	1000	CC349C	10-05-040:0707-06-500-3646	4-1790
OKI	OKI 1150	RP9040/64-23014		6.25	400	CC253A	10-05-016:0909-06-500-3646	4-1587
OKI	OKI 1150	RP9041/64-23015		6.25	1200	CC254B	10-05-048:0707-06-500-3646	4-1588
OKI	OKI 1325 & 1335	64-30002		6.25	0	CC371C	20-05-000	4-1838
OKI	OKI 1325 & 1335	64-30003		6.25	0	CC371C	10-05-000	4-1839
OKI	OKI 1325 & 1335	64-30004		6.25	0	CC371C	20-05-000	4-1840
OKI	OKI 700, 750	RP9001/64-19011		6.25	1000	CC171B	10-05-040	4-1326
OKI	OKI 900	RP9014/64-20001		6.25	600	CC169A	10-05-024:0909-06-500-3646	4-1442
OKI	OKI 900	RP9019/64-20002		6.25	1200	CC170B	10-05-048	4-1443
OKI	OKI Telecom	64-42081		12.00	2300	CC198C	30-06-092	4-1324
Olympus	Video	VF-BP3-D		12.00	2000	CC198C	30-06-080	4-1490
Orcatron Mfg.	Scubaphone	10 AA cells (& spkr)		12.50	500	CA252X	10-10-020:0101-06-500-3646	4-1586
Orcatron Mfg.	Scubaphone	10 AA cells (& spkr)		12.50	500	CD252X	10-10-020:0101-06-500-3646	4-1586A
Pace	LM265Q	B1Q		10.00	500	CC199A	10-08-020	4-1327
Panasonic		LCS-2312		12.00	2300	CC198C	30-06-092	4-1436
Panasonic		SH-DTB250		6.00	2000	CC265C	31-03-080:3033-650-0756	4-1607
Panasonic		VW-VBM10E		12.00	2300	CC198C	30-06-092	4-1770
Panasonic	EB-KJ3500	EB-P0016		7.50	700	CC185B	10-06-028	4-1462
Panasonic	General useage	LCR-456P		6.00	4800	UD-14	30-03-192	4-1558
Panasonic	General useage	LCR6V1.3P		6.00	1300	UA-15	31-03-052:3866-850-0756	4-1592
Panasonic	HP600	EB-P0369		6.25	400	CC186B	10-05-016	4-1463
Panasonic	HP600	EB-P0525		6.25	700	CC187B	10-05-028	4-1464
Panasonic	I Series	EB-P10154		6.25	900	CC327C	10-05-036	4-1757
Panasonic	I Series	EB-P10181		6.25	500	CC328C	10-05-020	4-1758
Panasonic	Power Tool	EZ902		2.50	1200	CC264C	10-02-048	4-1600
Panasonic	TP500	EB-P0057		11.25	1000	CC192B	10-09-040	4-1474
Panasonic	Video	PV-BP50		12.00	2000	CC275C	30-06-080	4-1633
Panasonic	Video	PVB-88		12.50	2300	CC198C	10-10-092	4-1486
Panasonic	Video Camera	BP-212		12.00	2300	CC198C	30-06-092	4-1511
Panasonic	Video Camera	LCS-2012AV		12.00	2300	CC198C	30-06-092	4-1512
Panasonic	Video camera	LCS-2012P		12.00	2000	CC198C	30-06-080	4-1329
Panasonic	Video camera	VW-VBM2		12.00	2000	CC198C	30-06-080	4-1330
Philips		AT14761		0.00	0	CC158A	10-00-000	4-1523
Philips	PF85, PFX85	AT14372		10.00	800	CC158A	10-08-032	4-1332
Philips	PF85, PFX85	AT14566		10.00	500	CC158A	10-08-020	4-1331
Philips	PFX	AT14883		10.00	800	CC158A	10-08-032	4-1416
Philips	PR710	(Unmarked) (1000)		10.00	1000	CC274B	10-08-040	4-1752
Philips	PR710	(Unmarked) (500)		10.00	500	CC274A	10-08-020	4-1630
Philips	PR710	(Unmarked) (800)		10.00	800	CC274B	10-08-032	4-1658
Philips	PRP70 Series	5322 138 10479		7.50	1200	CC314C	10-06-048	4-1714
Philips (UK)	PRP73 Series	9525 701 54012		7.50	1200	CC314C	10-06-048	4-1714-01
Physio Control	Life Pak 5	09-10424-09		12.50	1000	UD-13	10-10-040	4-1439
Physio Control	Life pak 5	09-10424-04		12.50	1000	UD-13	10-10-040	4-1334
PolyCell	P300	FER-03		10.00	1500	CC317C	10-08-060	4-1745-01
RAYTHEON	TAC Battery	G309202-1,		0.00	0	CD206M		4-1501
RCA		BP96FL		10.00	2000	CA262P	10-08-080:0505-06-500-3646	4-1598
Racal	CougarNet	MA4516A (500)		10.00	500	CC316C	10-08-020	4-1343
Racal	CougarNet	MA4516A (660)		10.00	660	CC316C	10-08-026	4-1343-01
Racal	Covert Cougar	MA4736B (250)		10.00	250	CC190B	10-08-010	4-1445
Racal	Covert Cougar	MA4736B (330)		10.00	330	CC190B	10-08-013	4-1445-01
Racal	Racal 4700	MA4705A		10.00	2000	CA346P	10-08-080	4-1344

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Racal	Scope Shield II	23386/SS-4100687-501	10.00	1200	CC230B	10-08-048	4-1489
Racal	Scope Shield II	23386/SS-4100687-501	10.00	1450	CC230B	11-08-058:3333-06-500-3646	4-1489A
Racal	Scope Shield II	23386/SS-4100687-501	10.00	1450	CC277C	11-08-058:3333-06-500-3646	4-1489B
Racal H.& S.	Air Stream	520015	6.25	4000	CA296X	10-05-160:0404-06-500-3646	4-1680
Racal H.& S.	Air Stream	520018	6.25	2000	CA296X	10-05-080:0808-06-500-3646	4-1681
Radio Shack	17-2001CT300	17-604	7.50	1000	CC146B	10-06-040	4-1349A
Radio Systems	PR60, PRC66	PR-BP	12.50	500	CC300X	10-10-020	4-1398-01
Ranger Comm	RCI-7000	BT-8	12.50	550	CC333B	10-10-022	4-1776
Regency	RSP500,RSP500B	BP600	10.00	600	CC157B	10-08-024	4-1775
Repco		819-251-S01	12.50	650	CA255P	10-10-026	4-1359
Repco		820-023-01	11.25	450	CC163B	10-09-018	4-1360
Repco		BP-4	11.25	500	CC152A	10-09-020	4-1356
Repco		BP-4 (600)	11.25	600	CC152A	10-09-024	4-1451
Repco	RHT800	820-037-01	11.25	600	CC362B	10-09-024	4-1808
Repco	Tek 10-2, RPX	817-005-01	12.50	450	CC154A	10-10-018	4-1352
Repco	Tek 10-2, RPX	817-066-01	12.50	450	CC154A	10-10-018	4-1353
Repco	Tek 10-2, RPX	817-125-01	12.50	600	CC154B	10-10-024	4-1357
Repco	Tek 10-8	810-156-01	15.00	500	CC153A	10-12-020	4-1354
Ritron	RT-50,-125,-153	BPX-8N	10.00	750	CC266A	10-08-030	4-1608
Rockwell Int'l		SUB-D-9, Fml, 1- 9+	16.00	0	CD345X	30-08-000	4-1785
Rockwell Int'l	HHM Battery	217-0083-010	15.00	450	CD205X	10-12-018	4-1500
Rohde & Schwarz		303.3110	12.00	10000	CD216X	30-06-400	4-1495
SOUTHWEST ELEC.	Garrett Metal Detect	NI-5058	7.50	350	CC298A	10-06-014	4-1695-01
Saft	Data entry unit	406929-000	6.25	700	CC261B	10-05-028	4-1597
Sanyo		3N-270AA	3.75	270	CA299X	11-03-011:3030-06-500-3641	4-1696
Sharp	Computer	EA-621EB	10.00	1200	CA249X	10-08-048	4-1581
Shinwa		ZG50, w/Case ZG51	5.00	1100	CC369B	10-04-044:0505-06-500-3646	4-1836
Shinwa		ZG58	7.50	900	CC368B	10-06-036:0707-06-500-3646	4-1835
Shinwa	SH405G2	ZG35B	10.00	600	CC157B	10-08-024	4-1366
Sinclabs	RSP500,RSP500B	BP0600	10.00	600	CC157B	10-08-024	4-1775-01
Sonnenschein		A206/3.0S	6.00	3000	UD-11	30-03-120	4-1721
Sony	Video Camera	BP-90	12.50	3500	CA161X	10-10-140	4-1376
Sony	Video Camera	BP-90A	12.50	5000	CA273X	10-10-200	4-1627
Sony	Video Camera	NP-1	12.50	1500	CC159C	10-10-060	4-1417
Sony	Video Camera	NP-11	10.00	1000	CC211X	10-08-040	4-1524
Sony	Video Camera	NP-1B	12.50	2300	CC159C	10-10-092	4-1411
Sony	Video Camera	NP-22H	6.25	1800	CC160C	10-05-072	4-1374
Sony	Video Camera	NP-66H	6.25	1800	CA203B	10-05-072:0606-06-500-3646	4-1568
Sony	Video Camera	NP-77	6.25	2000	CA203B	10-05-080:0602-06-500-3646	4-1375
Sony	Video Camera	NP-77H	6.25	2400	CA203B	10-05-096:0602-06-500-3646	4-1150
Sony	Video camera	BP-90	12.50	3500	CD161X	11-10-140:5050-06-500-3642	4-1376A
Sony	Video camera	NP-1A	12.50	1700	CC159C	10-10-068	4-1373
Spilsbury		AC19S	11.25	800	CC326B	10-09-032	4-1380
Spilsbury	PMS 1210/1610	AC19R	11.25	450	CC163B	10-09-018	4-1379
Standard		CNB241	7.50	700	CC168A	10-06-028	4-1440
Standard		CNB242	12.50	600	CC166A	10-10-024	4-1441
Standard		CNB584A	10.00	900	CC295B	10-08-036	4-1663

If battery is not listed, please contact Cadex Electronics

01/03/1995

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Standard	HX240	CNB243	7.50	1000	CC263B	10-06-040:0707-06-500-3646	4-1460
Standard	HX300	BP11	11.25	450	CC181B	10-09-018	4-1381
Standard	HX300	CNB2	11.25	450	CC181B	10-09-018	4-1382
Standard	HX340	CINB101AS	10.00	1100	CC149B	10-08-044	4-1061
Standard	HX340	CINB102AS	10.00	1100	CC149B	10-08-044	4-1559
Standard	HX400	CNB40	12.50	450	CC148A	10-10-018	4-1385
Standard	HX400	CNB41	12.50	800	CC148B	10-10-032	4-1386
Standard	HX500	CNB4	7.50	500	CC147A	10-06-020	4-1387
Standard	HX500	CNB5	7.50	900	CC147A	10-06-036	4-1388
Sunpak	Video Camera	RB-P88	12.00	2300	CC198C	30-06-092	4-1541
TELXON	Printer	12201-000	12.50	2200	CA204X	10-10-088:0505-06-500-3646	4-1499
TELXON	Printer	12201-000	12.50	2200	CD204X	10-10-088:0505-06-500-3646	4-1499A
TWC	PR60, PRC66	BP60-1	12.50	500	CC300X	10-10-020	4-1398
Tait	TU1500		10.00	500	CC199A	10-08-020	4-1395
Technophone		BPN	12.50	1600	CA325X	10-10-064	4-1756-01
Technophone		BPN - Bag Batt.	12.50	1600	CC325X	10-10-064	4-1756
Technophone	PC205	3071	7.50	600	CC324X	10-06-024	4-1461-01
Technophone	PC205	3480	7.50	800	CC324X	10-06-032	4-1755-01
Technophone	PC205	B4042	7.50	600	CC324X	10-06-024	4-1461-02
Technophone	PC205	B4194	7.50	800	CC324X	10-06-032	4-1755-02
Technophone	PC205	BP205	7.50	600	CC324X	10-06-024	4-1461
Technophone	PC205	BPHC205	7.50	800	CC324X	10-06-032	4-1755
Technophone	PC305	10211	6.25	380	CC323C	10-05-015	4-1739-01
Technophone	PC305	10227	6.25	800	CC323C	10-05-032	4-1740-01
Technophone	PC305	BP305	6.25	380	CC323C	10-05-015:0102-06-500-3646	4-1739
Technophone	PC305	BPHC305	6.25	800	CC323C	10-05-032	4-1740
Technophone	PC305	C10488	6.25	380	CC323C	10-05-015:0102-06-500-3646	4-1739-02
Technophone	PC305	C10489	6.25	800	CC323C	10-05-032	4-1740-02
Technophone	PC405	BP405	7.50	380	CC218C	10-06-015	4-1754-01
Tecnoservice		00384 (TCS-HC)	12.50	850	CC363C	10-10-034:0707-06-500-3646	4-1811
Toshiba	Computer	PA2404U	15.00	2200	CC297C	20-12-088	4-1682
Toshiba	Computer	PA2412U	10.00	2400	CA370P	10-08-096	4-1823
Toshiba	Computer	PA8703U	7.50	2000	CD234P	10-06-080	4-1494
Toshiba	T1200	PA7491U	7.50	2200	CC241C	10-06-088:0505-06-500-3646	4-1396
Toshiba	TCP9300	BTR-300 (NiMH)	5.00	600	CC322B	20-04-024:0202-26-500-3646	4-1743
Toshiba	TPC9300	BTE-300	5.00	1100	CC329C	20-04-044:0202-26-500-3646	4-1744
Ultimate Serv.A	Cellular	FZ-712A	7.50	700	CC223X	10-06-028	4-1536
Uniden		APX1050	7.50	1050	CC151B	10-06-042	4-1403
Uniden		APX1100	7.50	1100	CC151B	10-06-044	4-1404
Uniden		APX500	11.25	500	CC152A	10-09-020	4-1533
Uniden		APX650 I	11.25	500	CC150B	10-09-020	4-1786
Uniden	500, 600 President	CP580	7.50	850	CC176B	10-06-034	4-1449
Uniden	5500	B-5500L	6.25	1000	CC256B	10-05-040:0305-06-500-3646	4-1591
Uniden	FPH210,-510,-516	APX1000	11.25	1000	CC150B	10-09-040	4-1399
Uniden	SP310TS	APX1100 I	7.50	1100	CC334B	10-06-044	4-1773
Uniden	SPH, SPU	APX550	7.50	700	CC151B	10-06-028	4-1401
Varta		NPC 6/600 DKZ	7.50	600	CA236X	11-06-024:1050-06-450-3646	4-1405
Varta		RSH 4	1.25	4000	CA236X	11-01-160:5050-06-500-5646	4-1599
Vivitar	VIVITAR 283	VIVITAR NC3	5.00	500	CC225A	10-04-020	4-1528
Yaesu		FNB-14	7.50	1000	CC156B	10-06-040	4-1703
Yaesu	FTC-2003, -2203	NBP-9	11.25	500	CC152A	10-09-020	4-1406
Yaesu	FTC2003, FTC703	FNB-2	11.25	500	CC152A	10-09-020	4-1407
Yaesu	FTH-2008, FTH-7008	FNB-11	12.50	600	CC156A	10-10-024	4-1625
Yaesu	FTH-2008, FTH-7008	FNB-12	12.50	500	CC156A	10-10-020	4-1410

If battery is not listed, please contact Cadex Electronics

01/03/1995

APPENDIX A - BATTERY ADAPTERS

BATTERY MANUFACTURER	USED IN	ORIGINAL MFR. NO. / STYLE ISC	RATING Volts	RATING mAh	FOOT PRINT	BATTERY C-CODE	ORDER NO.
Yaesu	FTH-2009, FTH-7009	FNB-21	10.00	600	CC164A	10-08-024	4-1429
Yaesu	FTH-2070	FNB-15	12.50	600	CC155A	10-10-024	4-1408
Yaesu	FTH-2070	FNB-16	12.50	1000	CC155B	10-10-040	4-1409
Yaesu	FTH2006	FNB-22	12.50	500	CC156B	10-10-020	4-1753

If battery is not listed, please contact Cadex Electronics

01/03/1995

Foot Print Code: eg. CC155A

CA = Configured Adapter
CC = Configured Cup
CD = Configured Cable
PA = Passive Adapter
PE = Passive "AMP" Cable
UA = Universal Adapter
UD = Universal "D" Cable

Contact Tension
Sequence Number

Basic C-Code: eg. 10-06-040

10 = NiCd Std
11 = NiCd Fine
20 = NiMH Std
21 = NiMH Fine
30 = Lead Acid Std
31 = Lead Acid Fine

Rating (mAh = rating * 25)
# of cells

Please see manual for extended code information.

GLOSSARY

GLOSSARY

AUTO — Automated program exercises batteries to prevent "memory" and reconditions those unable to reach the target capacity.

Battery Parameter — Specifies battery chemistry, voltage and mAh rating.

Battery Voltage, Nominal — Please see Nominal Battery Voltage.

Capacity Offset — Corrects the capacity reading of a battery when different discharge rates are applied. On a faster than specified discharge, the capacity reading will be lower and should be corrected with a positive offset; on a slower discharge, a negative offset is applied. Capacity offset is commonly applied on Lead Acid batteries.

C-Code — The Configuration Code is the machine number that holds the battery parameters. The C-Code is retained in an EEPROM built into the Battery Adapters; the C-Code holds the battery parameters.

CH — Charge.

C-Rate — Unit by which charge and discharge times are scaled. NiCd batteries with a rating of up to 2000mAh are commonly charged and discharged at 1C. With 1C, the typical charge time is 90 minutes and the discharge time is 60 minutes.

Note: Batteries with less than 100% capacity require less time to charge and discharge.

Lower than 1C-Rate settings will prolong the charge and discharge times proportionally (i.e. 0.5C will double the charge and discharge times).

Lower discharge current will produce slightly higher capacity readings. Refer to capacity offset.

C-Rates can be set in the Menu Mode.

Example: If a battery is charged and discharged at half the rated current, the C-Rate must be set to 0.5C to produce the correct readings. A 10Ah battery can be charged and discharged with 2A when selecting a 0.2C-Rate. Refer to the manufacturer's specification regarding charge and discharge rates of a specified battery type.

DCH	Discharge.
Default	Preset action taken if no other instructions are given; the parameters assumed by the C4000 unless explicitly specified.
EEPROM	Electrically Erasable Programmable Read Only Memory device located in the Battery Adapter. The code retained in the EEPROM can be changed within the C4000 by the user up to 100,000 times.
EPROM	Erasable Programmable Read Only Memory containing the firmware program of the C4000. The EPROM is located on the mother board in the main housing.
Exercise	Battery is first discharged to 1V per cell, recharged and a second discharge-charge cycle applied.
External RAM	RAM that is provided to the CPU by a separate, discrete IC.
Fast-Charge	Recharges typical battery in about 85 minutes (1 C-Rate).
Final Capacity	Last capacity obtained after multiple discharge/charge cycle (PRIME) or recondition (AUTO) applied.
Full Capacity	Capacity of a fully-recharged battery. **Note:** The Capacity is derived by discharging the battery at the manufacturer's specified mAh rate to 1.00 volt per cell. The elapsed time is recorded and displayed as the usable battery capacity.
IC	Integrated Circuit, also sometimes referred to as a "chip".
Internal RAM	RAM that is built into the main CPU itself.
LED	Light-emitting Diode (red, yellow & green status lights).
LCD	Liquid Crystal Display.
mAh	Milliampere Hours. 1000mAh = 1Ah. **Example:** A battery rated at 1000mAh that provides 1000mA for one hour has a capacity of 100%.

Memory Term is commonly used to refer to Voltage Depression. Memory is a dendrite deposit on the cell plates that causes an increase of the internal resistance of the cell. If not corrected by periodic cycling, memory can destroy the battery prematurely.

Menu A list of options available to view and change system parameters.

Negative Slope Also known as Negative Delta V; the voltage drop that occurs when a NiCd battery has reached full charge. This voltage drop is applied to terminate the fast charge. Full-charge status is maintained with trickle charge.

Nominal Battery Voltage Based on number of cells multiplied by cell voltage (1.25 V per cell for NiCd, 2V per cell for Lead Acid).

PCB Abbreviation for Printed Circuit Board.

Plateau Timer On a battery with mismatched cells, each cell reaches full charge at different times, counteracting the negative slope. The result is a flat voltage curve rather than a negative slope. The Plateau Timer safely terminates the fast charge in the absence of the negative slope.

If terminated by the Plateau timer Code 12 is shown, indicating that the battery has mismatched cells.

PRIME A program that prepares new or stored batteries for field use by repeatedly cycling until the optimum performance is reached.

RAM Random Access Memory. Used by computers for fast access, temporary data storage.

RECON Recondition.

Recondition A method proprietary to CADEX battery analyzers which reverses damage caused by "memory". Method consists of controlled deep- discharge applied below 1 volt per cell.

Residual Capacity The amount of charge left in the battery after field use.

RS-232 Standard interface to serial printer and/or computer.

Smart Adapter A battery adapter with a memory chip built into it for storing the battery parameters.

Smart Cable — A battery cable with a memory chip built into it for storing the battery parameters.

Standby — Standby prevents memory if a NiCd battery must be kept on charge for operational readiness. Every 30 days, the battery is exercised by automatically restarting the program.

Target Capacity — Capacity level at which a battery is considered usable. In AUTO program, batteries that fail to meet the selected target are automatically reconditioned.

Transitional Capacity — Battery capacity derived after first full-charge but before repeated charge/discharge (PRIME) or recondition (AUTO) had been applied.

Trickle Charge — Float charge to maintain battery in operational readiness. Typical trickle charge is 10% of battery rating (0.1C).

INDEX

A
ADAPTER, 6-5
Analyzing Batteries, 2-3
Audible Tone Signals, 4-3
AUTO, 3-2, 3-6
Auto Scale, 14-2
Auto-Scale, 7-7, 11-11
B
Bad Adap, 6-4, 6-5
Basic C-Code, 7-3
Battery Adapter Errors, 6-5
Battery Adapter Styles, 6-2
Battery Adapters, 2-2, 14-2
battery analysis, 2-4
battery capacity, 2-4
Battery Fuse, 13-2
Battery Fuse Location, 13-3
Battery Label, 10-6
Battery Rating, 11-9
Battery Rating Code, 11-9
Battery Type, 11-7
Battery Types, 14-2
C
Calculation of Target Capacity, 3-10
Calibrate Station, 8-6
Capacity Offset, 11-15
C-Code Definition, 7-2
C-Code Structure, 7-3
Cell voltage definition, 11-8
Center Switch Position, 9-3
Changing control settings, 2-5
CHARGE, 3-2, 3-5
Charge Method, 11-19
Circuit Fuse, 13-2
Code Definition, 9-8
Company Name, 8-5
Computer Interface, 10-7
Configured Cups, 6-2, 6-3
Copy Settings, 8-3
C-Rate, 11-11
Custom, 3-8
Cycle 1 and Cycle 2, 9-8
Cycles 1 and 2, 9-12
D
"dead" batteries, 2-4
Data Retention, 10-2
Date/Time, 10-3
Definition of battery capacity, 11-10
Detailed Display, 2-6, 4-7
Detailed Display Messages, 4-9
Display, 14-3
Display (LCD), 4-6
Display Messages, 4-8
E
EMPTY, 6-5
End of Discharge, 11-18
End of Recondition, 11-19
Entering menu mode from Global Display, 7-6
Evaluation of Battery Results, 2-6
Event Log, 10-8
Exit Phase, 9-11
Extended C-Code, 7-3
F
Factory C-Code, 7-2, 8-2
Fan, 4-5
Faulty battery, 9-12
Final Capacity, 3-4
Fine C-Rate Resolution, 11-13
Float Voltage, 11-20
Full Load, 2-5
G
Global Display, 2-2, 2-6, 4-6
Global Display Messages, 4-8
H
Heat Rail, 4-5
I
ID numbers, 10-6
Installation, 6-4
Installing OPTION-P, 13-6
Interrupt, 2-5
INV CODE, 6-5
Inv Type, 6-4, 6-5
L
LABEL (2), 10-5
LABEL (4), 10-5
Label Printing, 10-5
Led Indicators, 4-2
Log Event Fields, 10-8

INDEX

M
Menu Display, 4-8
Menu Functions, 7-6
Menu Navigation, 7-6
Menu Tree, 7-4
Minimum Trickle Charge, 11-13
Modify Battery Code, 7-9
Modify Custom, 9-2
Motherboard Layout, 13-8
Multi-frame display, 7-4
N
Negative Slope, 11-17
Non-volatile, 13-5
NULL CODE, 6-5
Number of Cells, 11-8
O
OPTION-P, 10-2
P
Parallel Printer, 10-4
Power failure, 10-2
Power Supply, 14-2
Power Up, 2-2
Primary Fuse, 13-2
PRIME, 3-2, 3-3
Prime a new or stored Battery, 9-6
Print Formats, 10-5
Printer Interface, 10-4
Program Selection, 14-3
Program time, 3-3, 3-5, 3-6
Program Variations, 9-11
Q
Quick View of Battery Parameters, 7-4
R
Recommended C-Rate, 11-11
Recondition, 3-7, 9-12
Recondition Discharge, 11-14
replacement fuses, 13-3
Replacing Back-up Battery, 13-4
Replacing Fuses, 13-2
Replacing the EPROM, 13-5
Residual Capacity, 3-4
Reverse Load Charge, 3-5
Reverse polarity, 2-3
S
Scaling, 11-10
Self-discharge, 3-8
Self-discharge Test, 9-7
Serial Printer, 10-4
Serial-to-Parallel converter, 10-4
Service Report, 10-7
SERVICE REPORT., 10-5
Set Password, 8-3
Setting up Custom Program, 9-2
Smart Adapters, 6-2, 6-3
Smart Cables, 6-2, 6-4
Standard C-Rate Resolution, 11-13
Standby, 3-8
Start-up messages, 2-2
Static Precautions, 13-2
Station Target Capacity, 8-5
Structure of C-Code for NiCd, 11-4
Structure of C-Code for NiMH, 11-5
Structure of C-Code for SLA, 11-6
System Fault, 4-5
T
Target Selector Setting, 3-9
Temperature Sensor, 4-5, 11-17
Test and Go-To, 9-9
Thermal Protection, 4-5
Throughput, 14-3
To Reset, 8-2
Topping Charge Plateau, 11-22
Transitional Capacities, 3-4
Trickle Charge, 11-13
Typical Applications, 9-5
U
User C-Code, 7-2
UTILITIES, 8-1
V
Voltage Limit, 11-21