MOTOROLA

Integrated Information Systems Group
8201 E. McDowell Road
Scottsdale, AZ 85252-1417

Exhibit 8 – Users Manual

Parallel Card Acceptance Device (CAD)

FCC ID: E9U6188

Model No. T6188A (Parallel)

8.0 Parallel CAD T6188A Users Manual (Preliminary)

The following statement will replace the FCC Compliance Statement in the Final Users Manual:

FCC Compliance Statement

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions. (1) This device may not cause harmful interference. And (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the radiated limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- -- Reorient or relocate the receiving antenna.
- -- Increase the separation between the equipment and receiver.
- -- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- -- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference. And (2) this device must accept any interference received, including interference that may cause undesired operation.

The Parallel CAD was submitted and a grant of authorization received from the FCC as a modular device under the intentional radiator requirements of Part 15, Subpart C.

The party that incorporates this device into their product is responsible for verification of the emissions produced by the final product and must adhere to the limits specified in the Code of Federal Regulation 47, Part 15, Subpart B.

Furthermore, a label must be applied on the exterior of the final product referring to this enclosed module which states, "Contains FCC ID: **E9U6188**" or "Contains Transmitter Module FCC ID: **E9U6188**".

Caution: Any changes or modifications not approved by the party responsible for compliance could void the user's authority to operate the equipment

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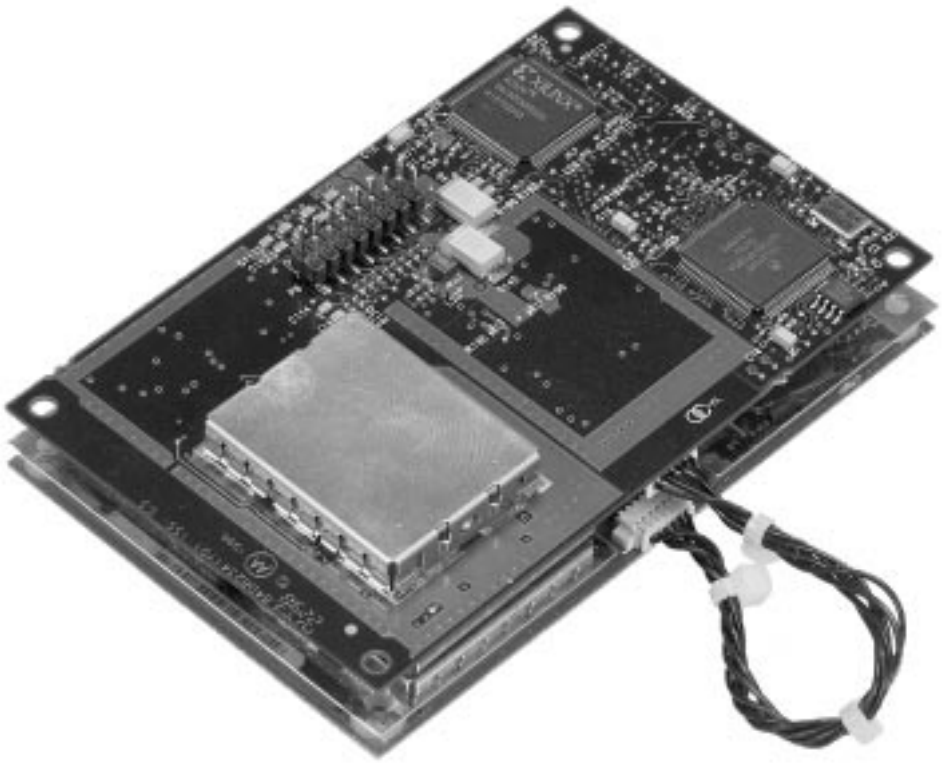
CARD ACCEPTANCE DEVICE (CAD)

Model T6188A (Parallel)



Instruction Manual

68P81131E18–O

MOTOROLA READER WARRANTY

Warranty: Motorola, Inc. ("Motorola") warrants its Motorola manufactured **smartcard reader or terminal ("Product")** to the original purchaser ("Buyer") as stated herein, except to the extent the terms herein may be modified by a written SmartCard Systems Agreement between Motorola and Buyer. Smartcards are not covered by this warranty.

Motorola warrants the Product against material defects in material and workmanship under normal use and service for a period of One (1) Year from the date of Product shipment. Motorola, at its option, will at no charge either repair the Product (with new or reconditioned parts), replace it with the same or equivalent product (using new or reconditioned parts), or refund the purchase price of the Product during the warranty period provided Buyer notifies Motorola within the warranty period in accordance with the terms of this warranty. Repaired or replaced product is warranted for the balance of the original applicable warranty period. All replaced parts of the Product shall become the property of Motorola.

Warranty Exclusions: This warranty does NOT cover:

1. Defects, damage or malfunctions of the Product resulting from:
   (a) Use of the Product in other than its normal and customary manner.
   (b) Misuse, accident, neglect, environmental or site conditions not conforming to the Product specifications.
   (c) Alteration, modification, adjustment, repair or testing of the Product not approved by Motorola.
   (d) Equipment not approved by Motorola for use with the Product.
   (e) Excessive power conducted or radiated from equipment not approved by Motorola for use with the Product.
2. Product which has had the serial number removed or made illegible.
3. Normal and customary wear and tear.
4. Fraud, theft or loss resulting from unauthorized use of the Product.
5. Loss of value or data stored in the Product or in other equipment used with the Product.
6. Disclosure of personal or confidential information or data stored in or accessed by the Product.
7. Loss or damage from Product or system downtime.
8. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
9. That the software in the Product will meet the purchaser's requirements or that the operation of the software will be uninterrupted or error–free.

General Provisions: This express warranty is extended by Motorola to the original Buyer purchasing the Product, and is not assignable or transferable to any other party. This is the complete warranty for the Product. Motorola assumes no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of Motorola. Unless made in a separate written agreement(s) between Motorola and Buyer, Motorola does not warrant the maintenance or service of the Products other than stated herein.

Motorola cannot be responsible in any way for any ancillary equipment not furnished by Motorola which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use the Product is unique, Motorola disclaims liability for read range, transaction time, or operation of the system as a whole under this warranty other than stated above.

This warranty sets forth the full extent of Motorola's responsibilities regarding the Product. Replacement or refund of the purchase price, at Motorola's option, is the exclusive remedy. THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER EXPRESS WARRANTIES. MOTOROLA DISCLAIMS ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS OR OTHER INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

Patent and Software Provisions: Motorola will defend, at its own expense, any suit brought against the Buyer to the extent that it is based on a claim that the Product or its parts infringe a United States patent, and Motorola will pay those costs and damages finally awarded against the Buyer in any such suit which are attributable to any such claim, but such defense and payments are conditioned on the following:

(a) that Motorola will be notified promptly in writing by Buyer of any notice of such claim;
(b) that Motorola will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and
(c) should the Product or its parts become, or in Motorola's opinion be likely to become, the subject of a claim of infringement of a United States patent, that Buyer will permit Motorola, at its option and expense, either to procure for Buyer the right to continue using the Product or its parts or to replace or modify the same so that it becomes non−infringing or to grant Buyer a credit for the Product or its parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or its parts as established by Motorola.

Motorola will have no liability with respect to any claim of patent infringement which is based upon the combination of the Product or its parts furnished hereunder with software, apparatus or devices not furnished by Motorola, nor will Motorola have any liability for the use of ancillary equipment or software not furnished by Motorola which is attached to or used in connection with the Product. The foregoing states the entire liability of Motorola with respect to infringement of patents by the Product or any its parts thereof.

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FCC/CE Compliance Information

This apparatus has been designed for incorporation into other equipment as a component of another system or end use product. This equipment is NOT intended to be placed on the market for final use.

It is the responsibility of the purchaser of this apparatus to obtain all regulatory approvals required for the local markets where the end use equipment will be sold. This may include, but is not limited to, FCC Part 15, CE mark, and Type approvals (as an intentional radiator). End products that incorporate this device may also be required to meet ETSI 300−300 and ETSI 300−683 requirements as of 4/15/1999.

This apparatus is intended to comply with the limits for class A digital device pursuant to Part 15 of the FCC Rules and ETSI 300−300 and ETSI 300−683, when assembled and operated as described in this manual. The limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. Operation of this equipment in a residential area is likely to cause interference in which case the user will be required to correct the interference at his own expense.

The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate this equipment.

MOTOROLA

Worldwide SmartCard Solutions Group

CARD ACCEPTANCE DEVICE (CAD)

Model T6188A (Parallel)

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Worldwide SmartCard Solutions Group
1301 E. Algonquin Road, Schaumburg, IL 60196

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12/15/99–xx

chapter 5

CAD Protocols and Commands

Appendix

FOREWORD

Product Maintenance Philosophy

Due to the high percentage of surface-mount components and multi-layer circuit board design, the maintenance philosophy for this product is one of Field Replaceable Unit (FRU) substitution. Each Control Board and Antenna Board matched set is considered a FRU, and when determined to be faulty, may be quickly and easily replaced with a known good set to bring the equipment back to normal operation. The faulty CAD set must then be shipped to the Motorola Radio Support Center in Rockford, Illinois for further troubleshooting and repair to the component level.

Customer Support

Motorola System Support Center
1311 E. Algonquin Road
Schaumburg, IL 60196

1−800−221−7144
FAX 847−576−2172
Int'l 847−576−7300

For complete information on ordering FRU replacement modules, or instructions on how to return faulty modules for repair, contact the Motorola System Support Center (see sidebar).

The CAD set (Control Board and Antenna Board) is considered a FRU. If the CAD is determined to be faulty, the entire CAD must be returned and will be repaired or replaced with a new CAD. Return faulty CADs to:

WSSD / Smartcards
c/o Motorola Inc.
8220 E. Roosevelt
Room 4139
Scottsdale, AZ 85257

Attn: Returned Goods

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. In keeping with the maintenance philosophy of Field Replaceable Units (FRU), this manual contains functional information sufficient to give service personnel an operational understanding of all FRU modules, allowing faulty FRU modules to be identified and replaced with known good FRU replacements.

The information in this manual is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMRs are added to the manuals as the engineering changes are incorporated into the equipment.

PERFORMANCE SPECIFICATIONS

Electrical

Required Supply Voltage	12 V dc +10% / −5%; ripple less than 50 mV P-P
Required Supply Current	300 mA @ 12 V dc
Maximum Input Power Requirements	3.6 Watts
CAD Power-Up Time	Less than 1.2 seconds after power applied
Spurious and Intentional Emissions	Designed to be Compliant with FCC Regulation Part 15.225 and 15.209 Designed to be Compliant with I-ETS 300 330 clause 7.2.1.3, 7.4.3.2, 7.4.4.2

Environmental

Operating Temperature	0° C to 70° C; Compliant with IEC 68-2-2 Part 2 Test Bd and IEC 68-2-1 Part 2 Test Ad, with duration of 16 hours
Storage Temperature	−40° C to 85° C; Compliant with IEC 68-2-2 Part 2 Test Bb and IEC 68-2-1 Part 2 Test Ab, with duration of 72 hours
Humidity	Operating: 5% to 95% non-condensing Compliant with IEC 68-2-3 Part 2 Test Ca, with duration of 4 days; high humidity test only
Cold and Heat Shock	Compliant with IEC 68-2-1 Part 2 Test Aa, with temperature −40° C and duration of 2 hours, and IEC 68-2-2 Part 2 Test Ba, with temperature 85° C and duration of 2 hours
Vibration	Compliant with IEC 68-2-6 with the following parameters: Frequency Range: 10 Hz to 500 Hz Vibration Severity: 3 gn Sweep Rate: 1 octave per minute Endurance by Sweeping: 20 sweep cycles for each X, Y, and Z axis Critical Frequency Duration: 10 million cycles or 10 hours at the fundamental resonant frequency
Shock	Compliant with IEC 68-2-27 Part 2 Test Ea; severity 60 gn; duration 11 msec
Bump	Compliant with IEC68-2-29 Part 2 Test Eb; severity 40 gn; duration 6 msec; number of bumps: 4000
Electromagnetic Fields	Compliant with ISO 10536-1, 4.2.8

Transmitter

Frequency	13.56 MHz ± .01%
Maximum Output Coil Current	1.00 App
Modulation Rise and Fall Time	<2.0 μsec
ASK Modulation	8% to 14%

Receiver

Carrier Frequency	13.56 MHz
Subcarrier Frequency	847.5 kHz
Subcarrier Data	NRZ-L BPSK (ISO 14443, Type B)

Operational

CAD-to-Terminal Communication Rates	Byte-Wide Parallel Transfer @ 25,000 bytes per second
CAD-to-Card Communication Rates	105.9375 Kbps
CAD-to-Card Operating Radio Frequency	13.56 MHz
ISO Card Type	ISO14443, Type B

Notes...

Chapter 1 ▶ Description

chapter contents

1 PRODUCT OVERVIEW

The Motorola Card Acceptance Device (CAD) is an electronic module capable of communicating with ISO 14443 Type B-compatible smart cards via a radio frequency (RF) interface. This section provides general information about the application and physical properties of the CAD.

Physical Description

Overview

The CAD, which provides the communications interface between a terminal and customer smart cards, consists of a Control Board and an Antenna Board. These two boards are connected together by a 100 mm multi-conductor interconnect cable. The CAD is connected to the terminal via a 16-pin connector located on the Control Board.

Control Board

The Control Board contains a microprocessor, non-volatile memory, and radio frequency transmitting and receiving circuitry. This board communicates with smart cards via an RF link (provided by the Antenna Board), and to the terminal via a byte-wide, proprietary parallel protocol.

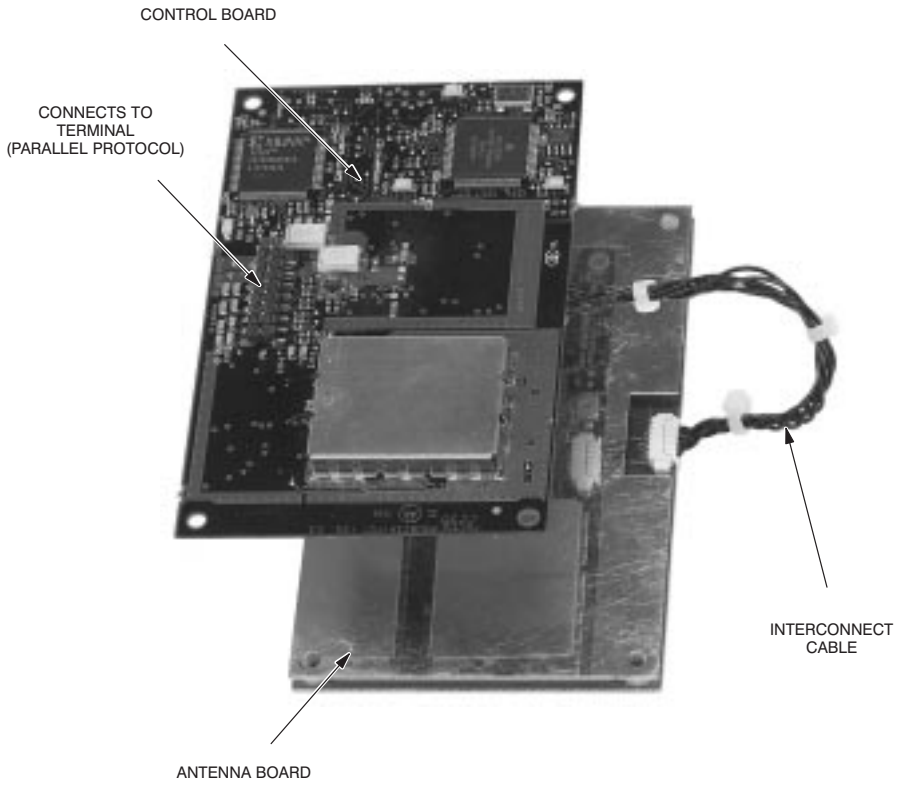
Antenna Board

The Antenna Board consists of printed circuit board with copper traces forming the transmit and receive antenna. The board is attached to a ferrite plate and a metal back plate that serves as a ground plane.

Typical Application

The CAD described in this manual is specifically designed to operate in *ERG Transit Systems* Automated Fare Collection Terminals for the purpose of allowing customers to electronically pay fares on mass transit vehicles.

CAD Primary Components



2 SIMPLIFIED BLOCK DIAGRAM THEORY

The illustration on the facing page shows a simplified block diagram of the CAD. This section is intended to provide a basic understanding of the CAD circuitry and how it interacts with the terminal and smart cards. (Refer to Chapter 4 for a more detailed block diagram and circuit descriptions.)

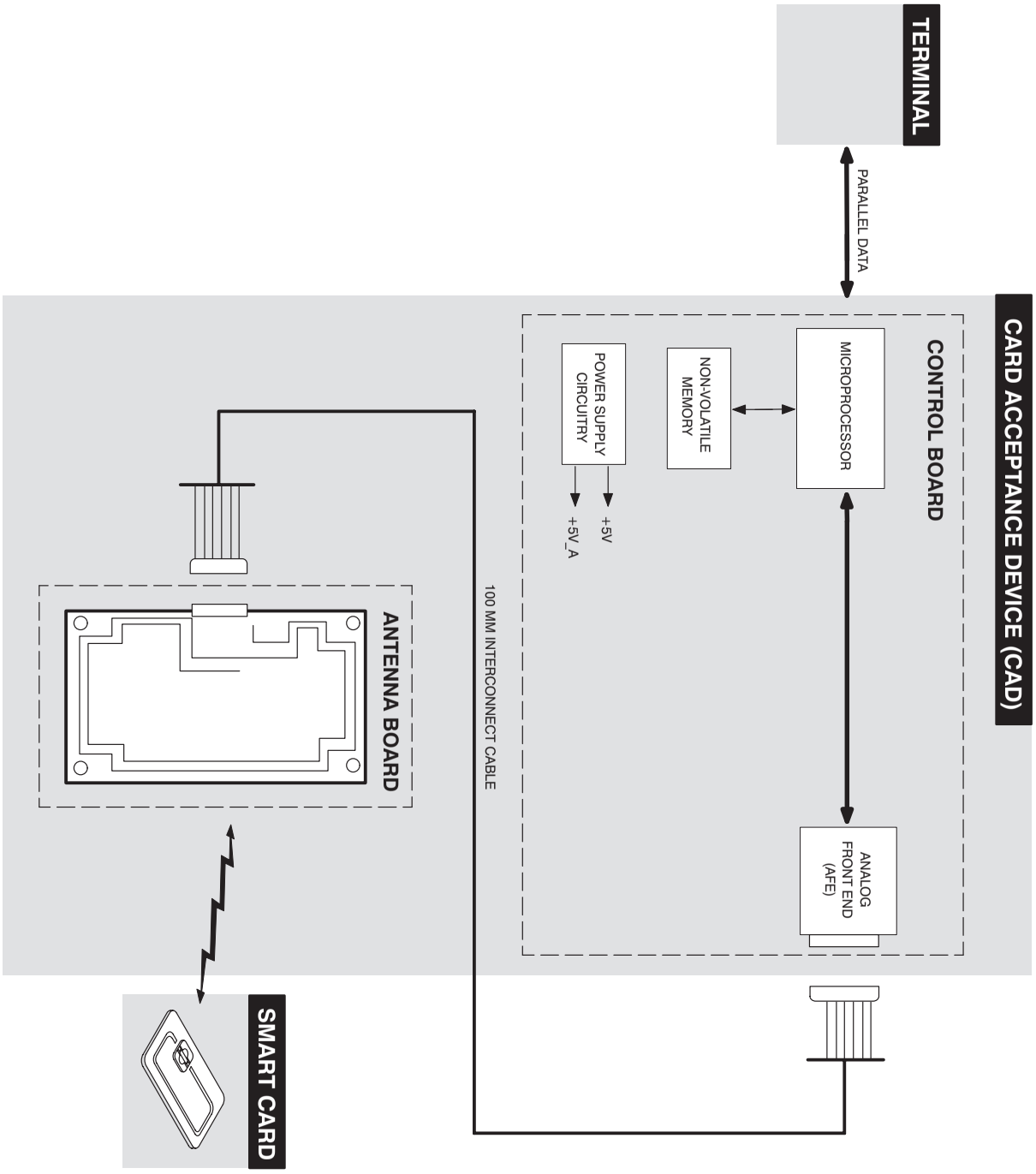
Overview of CAD Operation

The CAD serves as the data communications link between customer smart cards and the terminal in which the CAD is installed.

For CAD-to-Card communications, the Control Board receives data signals from the terminal. It then transmits these data signals via RF to a smart card held within reading distance of the CAD's Antenna Board.

For Card-to-CAD communications, encrypted RF data signals from the smart card are received by the Control Board (via the Antenna Board) where they are sent to the terminal via the 16-pin parallel connector located on the board.

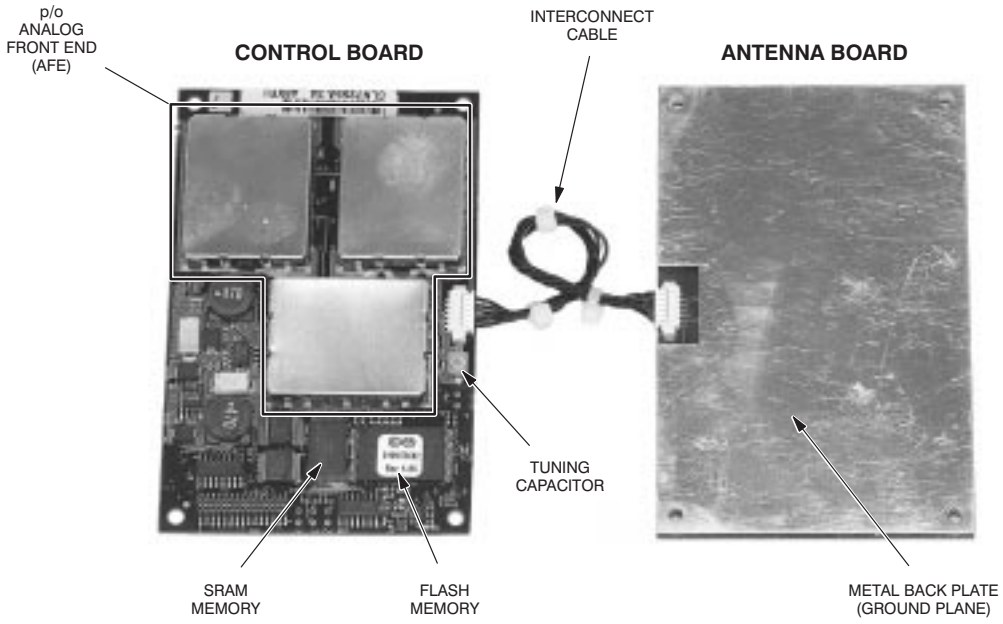
CAD Simplified Block Diagram

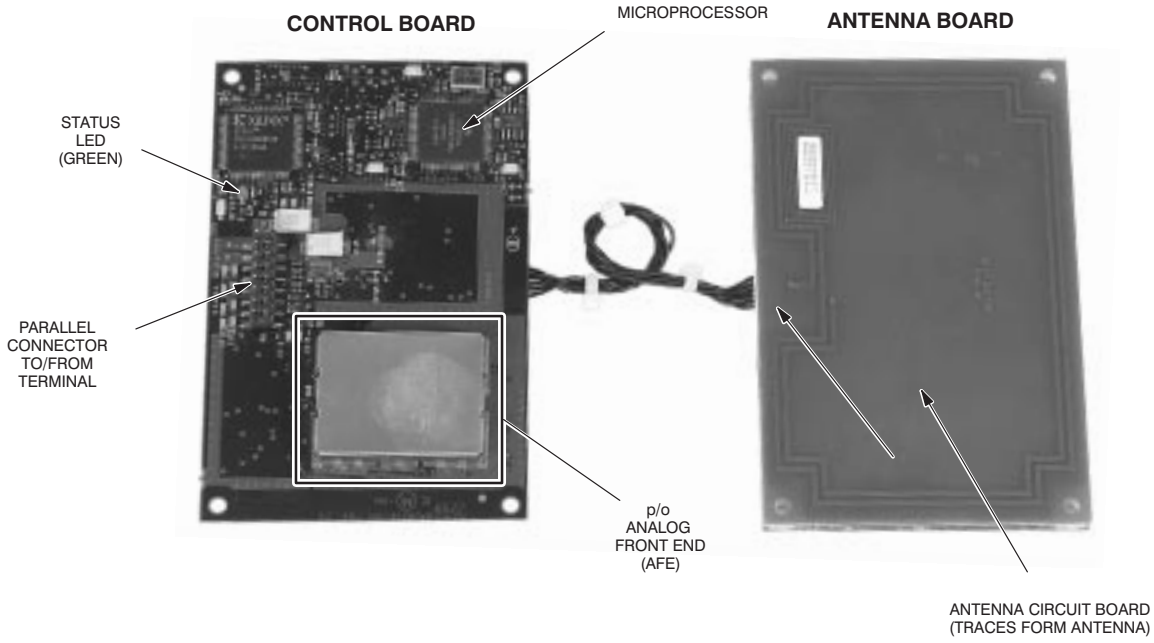


CAD Detailed Components

The Control Board contains components on both sides of the circuit board. The Antenna Board contains no components, but rather printed circuit traces which form the antenna. Refer to the photos on the facing page for identification of the components on the two boards.

CAD Detailed Components





Notes...

Chapter 2 ▶ Installation

chapter contents

1 UNPACKING AND INSPECTION

This section describes the procedures necessary to unpack and take inventory, run a Self Test utility to verify proper electrical operation, perform a tuning procedure, mechanically install the CAD set into an external terminal enclosure, and perform a final checkout procedure.

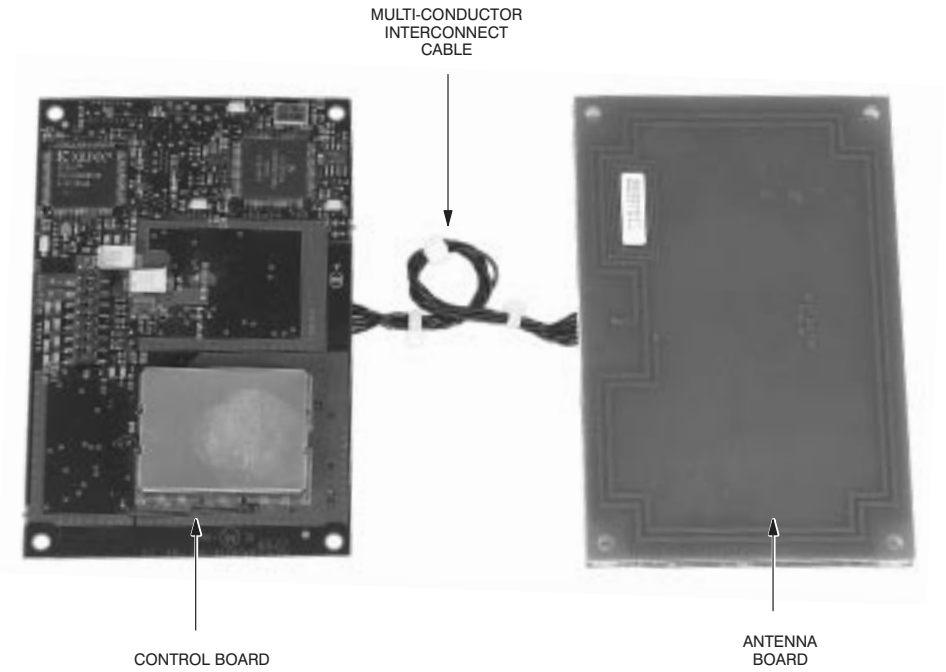
Important! *The CAD Control Board contains C-MOS and other static-sensitive components. When handling the CAD, be sure to observe all precautions to prevent damage to the components from static electricity. These include the use of a grounded anti-static wrist strap and anti-static mats and work surfaces.*

Unpacking and Inspecting the CAD Sets

Each CAD set (consisting of a Control Board and an Antenna Board) is tuned and tested at the factory prior to shipment. Each CAD set is shipped with a 100 mm multi-conductor interconnect cable connected between the Control Board and the Antenna Board.

Remove each CAD set from the foam packing material and inspect for visual damage. Report the extent of any damage to the transportation company.

CAD Set Connected by Cable



2 VERIFYING PROPER OPERATION

Although each CAD set is tested at the factory before shipment, it is recommended that the *Auto-Test* utility be run on each CAD set prior to installation into a terminal. This ensures that the CAD set is electrically functional and was not electrically damaged in transit or during unpacking.

The *Auto-Test* utility is part of the *CADTools* program included with the Model T6439A Parallel CAD Installation Kit (available from Motorola). The *CADTools* program is a *Microsoft Windows* compatible program that includes a suite of factory test utilities and a firmware download utility for updating the CAD operating software.

Required Equipment

The following hardware and software is required in order to run the Self Test Utility on a CAD set.

- Model T6439A Parallel CAD Installation Kit (includes Test Cable, Power Supply, ISO Antenna Board, and *CADTools* Software.
- *IBM* PC or *IBM*-compatible desktop or laptop computer (Pentium II class processor running at 200 MHz or greater, Windows 95/98 operating system)

Installing the *CADTools* Software

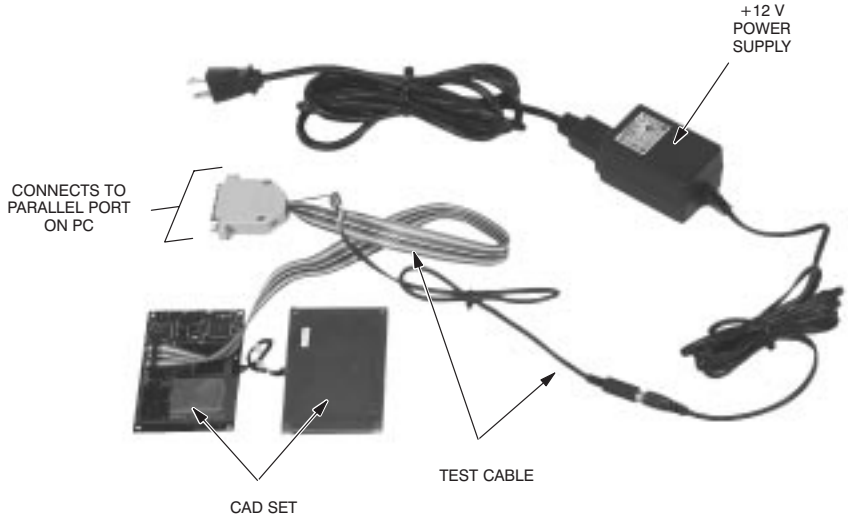
The *CADTools* software is provided on two 3½" high density diskettes. Install the software by performing the procedures located in the *CADTools User's Guide* (supplied with the software in printed and/or electronic format).

Launching the *CADTools* Software

1. Before launching the *CADTools* program, the CAD must be powered and connected to the PC, as shown below. Make these connections using the cables and power supply provided in the Model T6439A Parallel CAD Installation Kit.

Important! *Do not attach or remove the ribbon cable from the 16-pin connector on the Control Board with DC power on (either from the Terminal or from the DC Power Supply included with the Installation kit). Doing so may result in corrupted Control Board firmware.*

Important! *Make sure that the PC's parallel port is set for* ***bi-directional****. This setting is usually provided in the PC's BIOS setup menu (accessed by pressing a designated key during the PC's bootup period).*



2. Click on the Start button, then select:
Programs ⇒ Motorola ⇒ CADTools

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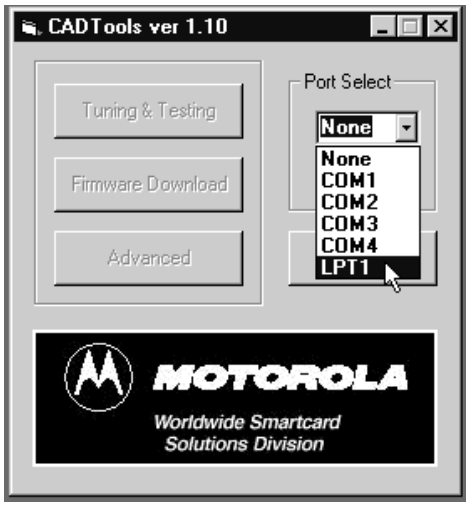
Launching the *CADTools* Software (continued)

3. The *CADTools Main Screen* will appear. Click in the *Port Select* list box and select **LPT1**.



4. The following screen may appear, prompting you to power cycle the CAD. Disconnect, then reconnect the black DC power connector to power cycle the CAD. Then click on **OK**.

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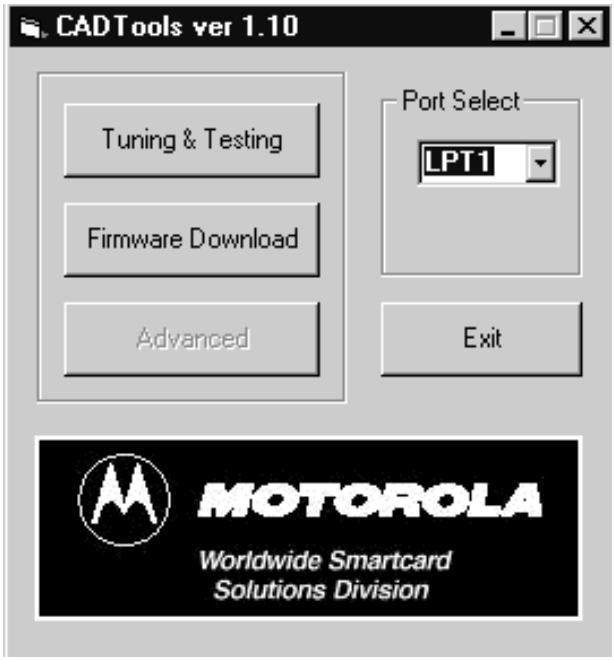
Launching the *CADTools* Software (continued)

5. The *CADTools* main screen will appear. It is from this screen that you can access the *Tuning & Testing* tool (used to run self-test diagnostics and perform field tuning) and the *Firmware Download* utility (used to download CAD operating software from the PC into FLASH memory in the CAD Control Board).



◆ ***End of this Procedure*** ◆

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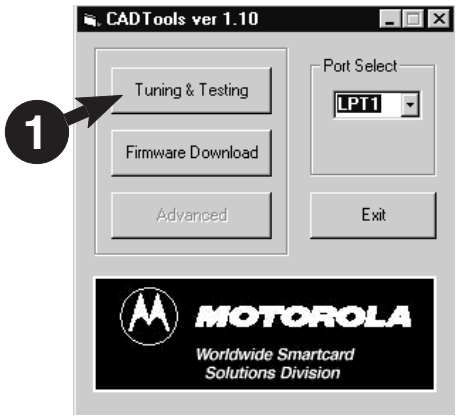
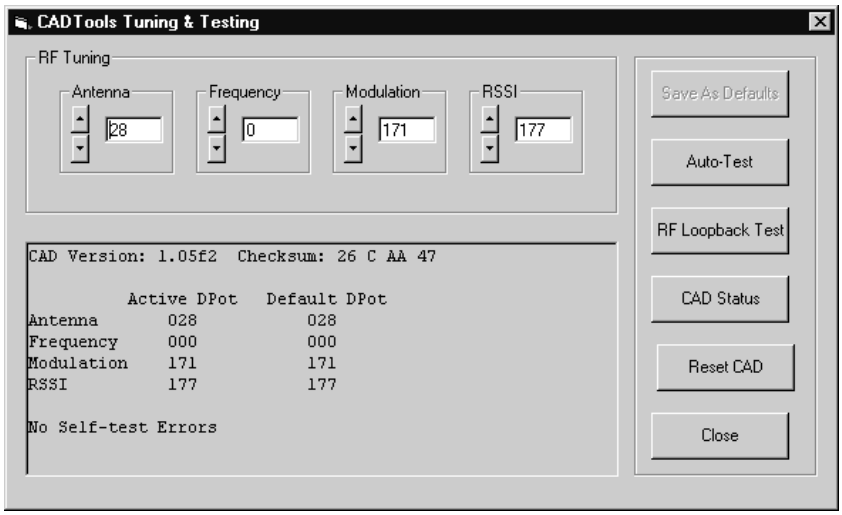
Running the Self-Test Utility

1. With the CAD connected to the PC and the *CADTools* program running (refer to *Launching the CADTools Software* on page 2−5), click on the **Tuning & Testing** button.



2. The following *CADTools Tuning & Testing* main screen will appear.



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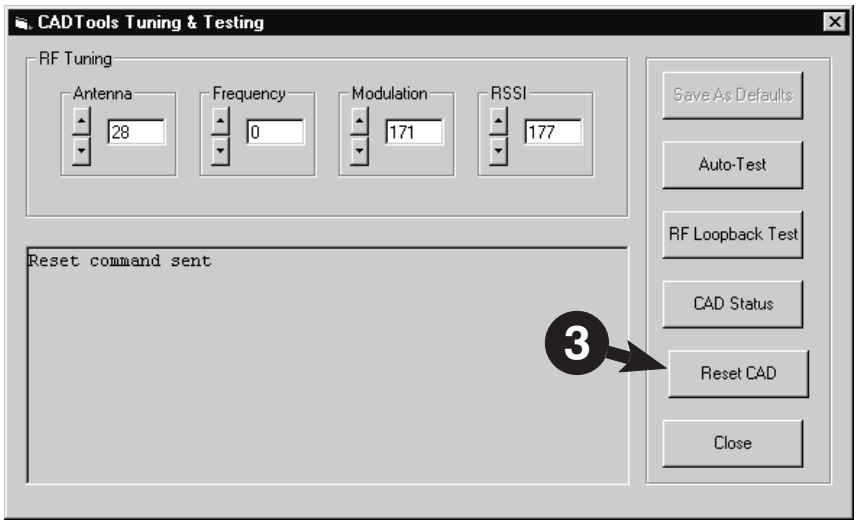
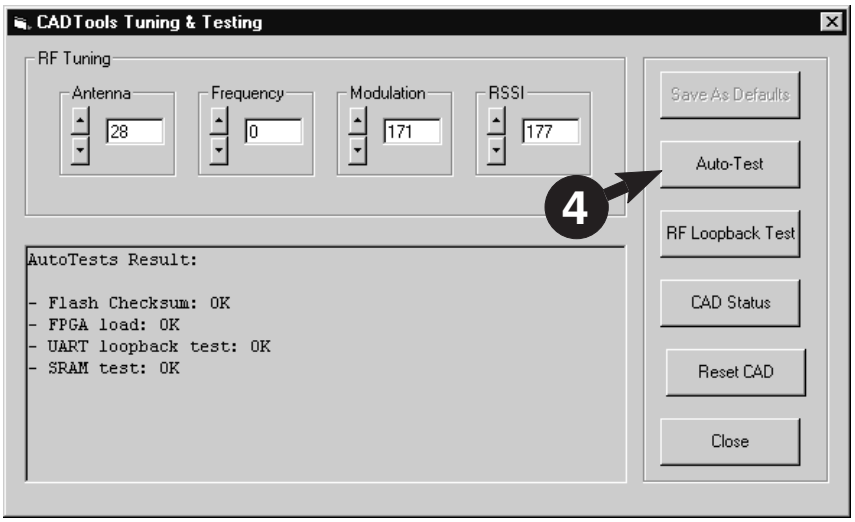
Running the Self Test Utility (Continued)

3. Click on the **Reset CAD** button to cause the CAD set to perform a reboot process. When complete, *Reset command sent* will be displayed.



4. Click on the **Auto-Test** button to initiate the self-test routine. The results will be displayed as shown below. Verify that all test results are **OK**.



◆ ***End of this Procedure*** ◆

3 TUNING PROCEDURE

Although each CAD set is tuned at the factory, it is recommended that the tuning procedure be repeated before permanently installing the CAD into the terminal. This ensures that the CAD's read range and reliability are optimized.

When a SmartCard is presented to the Terminal/Reader, the card must be positioned a certain minimum distance from the CAD Antenna Board ("read range") in order to be recognized and carry out the transaction. In order to maximize this read range, the CAD must be tuned while installed in the intended Terminal housing (since any metal, such as shielding, brackets, screws, etc., in the Terminal, especially between the Antenna Board and the card reader surface, dramatically affects the optimum read range).

Since the CAD is installed in the *V3000 AFC Terminal* bottom housing and then covered with the top housing, there is no way to access the tuning capacitor on the CAD Control Board to make tuning adjustments. Therefore, a tuning "fixture" must be constructed using a *V3000 AFC Terminal* top housing and a non-ferrous spacer (a small pad of paper works well). The following tuning procedure describes how to construct this fixture.

Note *To perform the tuning procedure, you will use the* ***CADTools*** *program. This software application was used previously to perform the Self-Test utility to verify that the CAD is electrically functional. Refer to page 2–4 for instructions on installing this software application on your PC.*

Required Equipment

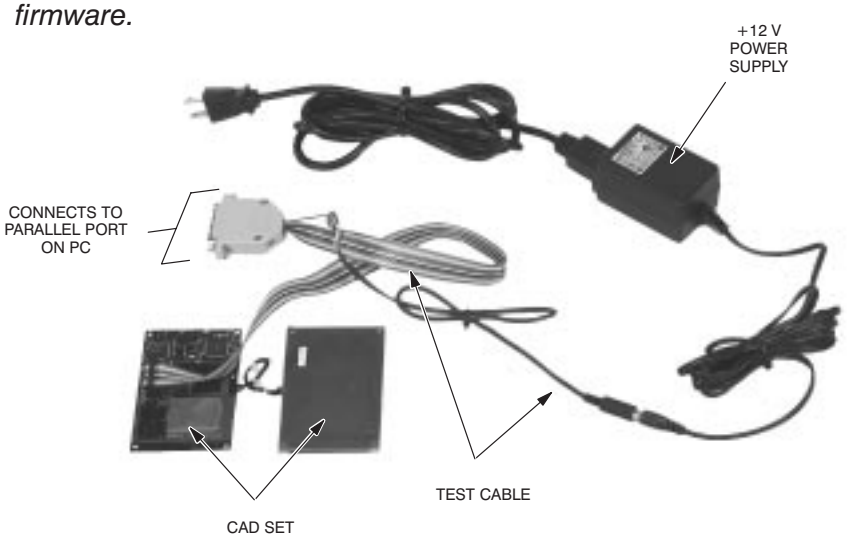
The following hardware and software is required in order to perform the tuning procedure on a CAD set.

- Model T6439A Parallel CAD Installation Kit (includes Test Cable, Power Supply, ISO Antenna Board, and *CADTools* Software.
- *IBM* PC or *IBM*-compatible desktop or laptop computer (Pentium II class processor running at 200 MHz or greater, Windows 95/98 operating system)
- Model *V3000 AFC Terminal* Housing Cover
- Oscilloscope (Tek TDS420A, or equivalent)
- Frequency Counter (HP 53132A, or equivalent)

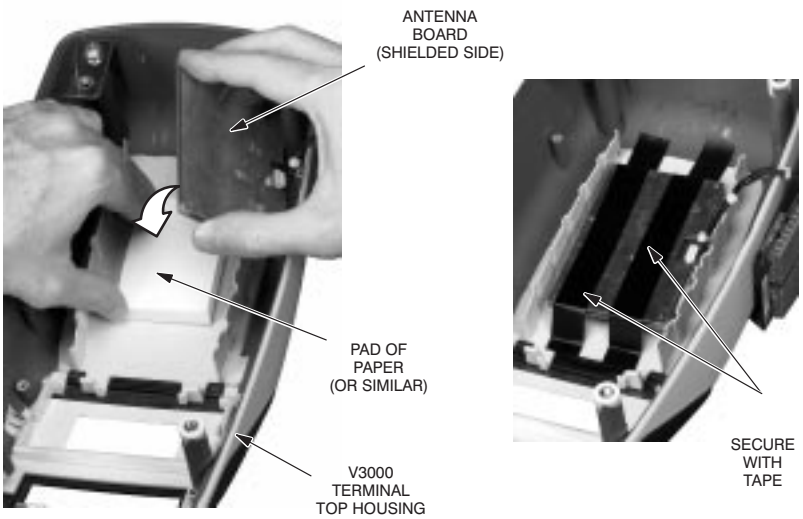
Tuning the CAD

1. Connect the CAD, PC, and power supply as shown below.

   Important! *Do not attach or remove the ribbon cable from the 16-pin connector on the Control Board with DC power on (either from the Terminal or from the DC Power Supply included with the Installation kit). Doing so may result in corrupted Control Board firmware.*



2. Using tape, affix a non-ferrous spacer (e.g., small pad of paper) to the inside of the top housing as shown below. Note that the pad must be the same thickness as the distance from the reader surface ("target" spot on the outside of the top housing) to the top of the Antenna Board (when it is mounted in the bottom housing).



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Tuning the CAD (continued)

3. Attach the scope probe to the ISO Antenna wires and position the antenna on the “target spot” (over the CAD Antenna Board). While monitoring the waveform on the oscilloscope, move the antenna around until you achieve the maximum Vpp reading (approximately 5 to 10 Vpp). Secure the ISO Antenna in place using electrical tape or equivalent.

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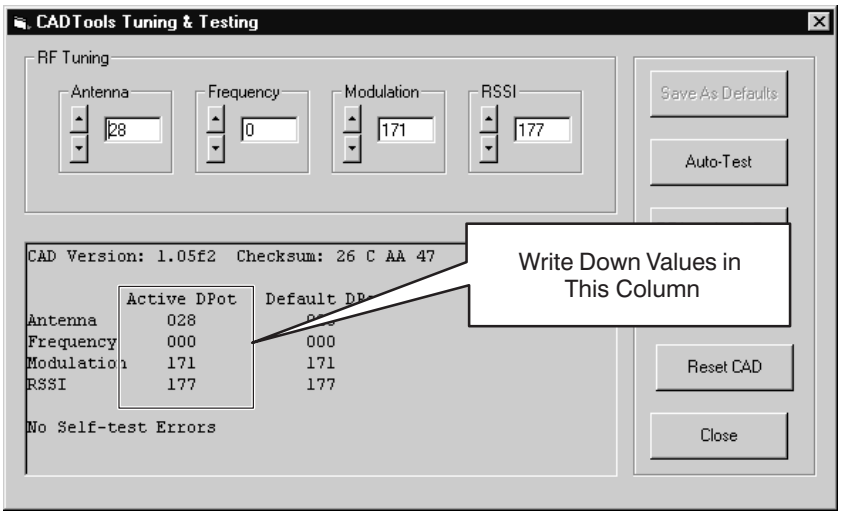
Tuning the CAD (continued)

4. Launch the *CADTools* program (described on page 2−5) and click on the **Tuning & Testing** button to access the *CADTools Tuning & Testing* main screen. The current settings from the CAD will be retrieved and displayed, as shown below. Write down the values in the Active DPot column.



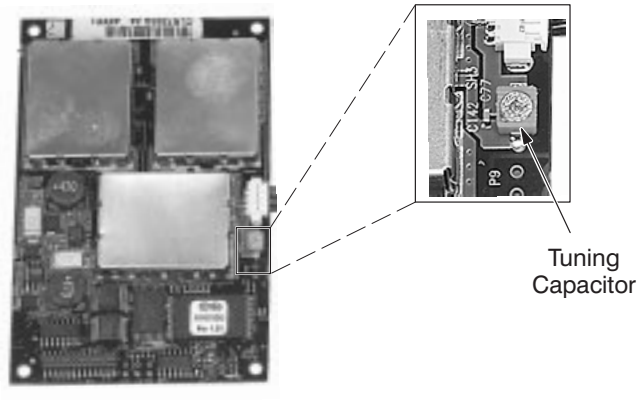
Note *The Frequency adjustment box is functional only on Serial CADs. For Parallel CADs, the arrows in the Frequency adjustment box have no effect on the CADs frequency.*

5. Connect the Frequency Counter probe to the two wires on the ISO Antenna. Verify that the frequency reading is:
   13.56 MHz ± 1.356 kHz
   If not, return the CAD set to the factory.
6. Disconnect the Frequency Counter probe, then connect the Oscilloscope probe to the two wires on the ISO Antenna.

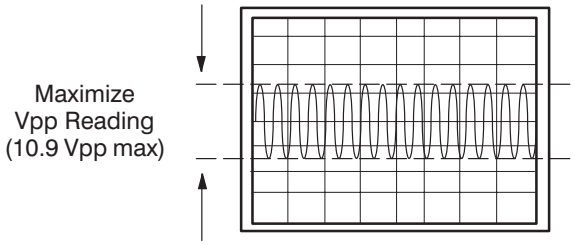
— continued on next page —

Tuning the CAD (continued)

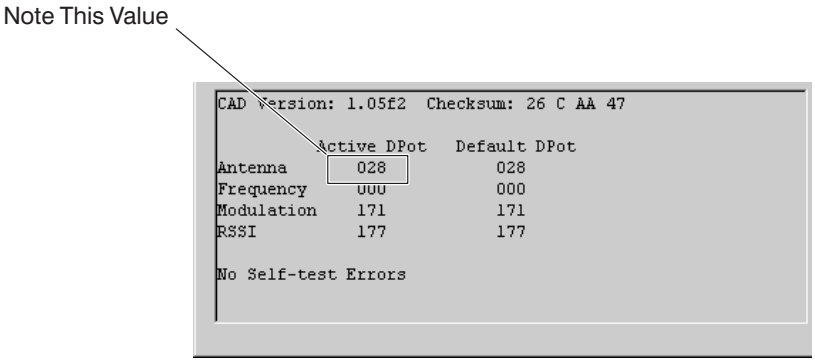
7. Locate the tuning capacitor on the CAD Control Board and adjust it using a plastic tuning tool to achieve the maximum Vpp reading on the oscilloscope.



8. Click on the up/down arrows in the *Antenna* adjustment box (to increment/decrement the value one step at at time) and note the waveform on the oscilloscope. Continue to adjust the *Antenna* value up or down as necessary to obtain the maximum Vpp reading (not to exceed 10.9 Vpp).



9. Click on the **CAD Status** button to obtain a new status report. Note the value for the *Antenna* in the *Active DPot* column.



Tuning the CAD (continued)

10. Look up the *Antenna* Vpp value (obtained in Step 8) in the *V max* column in the table below and note the corresponding value in the *Vmin (11%)* column.

V max	V min (8%)	V min (11%)	V min (14%)
11	9.370	8.820	8.298
10.9	9.285	8.740	8.223
10.8	9.200	8.659	8.147
10.7	9.115	8.579	8.072
10.6	9.030	8.499	7.996
10.5	8.944	8.419	7.921
10.4	8.859	8.339	7.846
10.3	8.774	8.259	7.770
10.2	8.689	8.178	7.695
10.1	8.604	8.098	7.619
10	8.519	8.018	7.544
9.9	8.433	7.938	7.468
9.8	8.348	7.858	7.393
9.7	8.263	7.777	7.318
9.6	8.178	7.697	7.242
9.5	8.093	7.617	7.167
9.4	8.007	7.537	7.091
9.3	7.922	7.457	7.016
9.2	7.837	7.377	6.940
9.1	7.752	7.296	6.865
9	7.667	7.216	6.789
8.9	7.581	7.136	6.714
8.8	7.496	7.056	6.639
8.7	7.411	6.976	6.563
8.6	7.326	6.895	6.488
8.5	7.241	6.815	6.412
8.4	7.156	6.735	6.337
8.3	7.070	6.655	6.261
8.2	6.985	6.575	6.186
8.1	6.900	6.495	6.111
8	6.815	6.414	6.035

11. Click on the up/down arrows in the *Modulation* adjustment box (to increment/decrement the value one step at at time).

12. Note the Vpp waveform on the oscilloscope. Continue to adjust the *Modulation* value up or down as necessary to obtain the Vpp value noted from the table above. If this value cannot be obtained, continue the process to obtain a value within the 8% and 14% range (as determined by the table above).

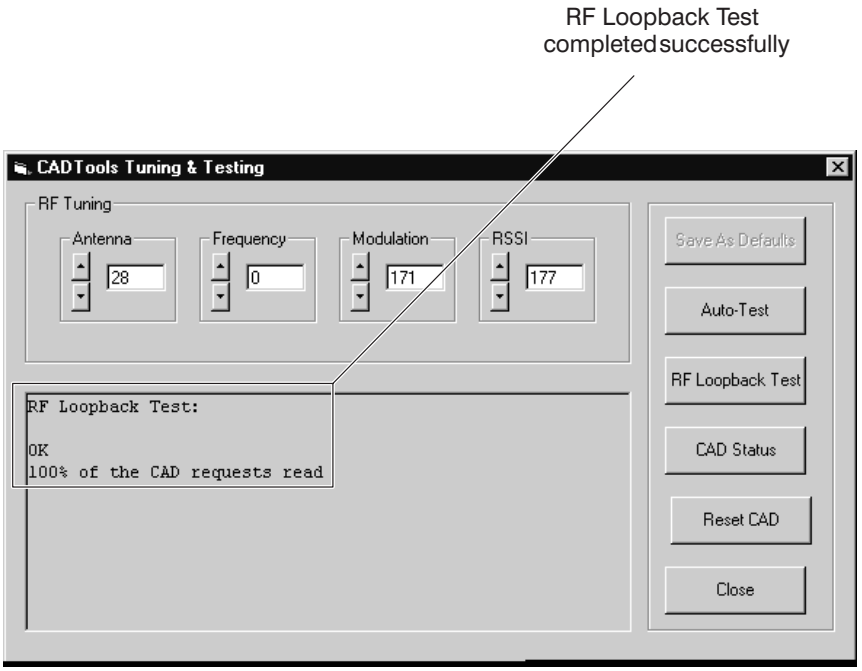
Tuning the CAD (continued)

13. Since the *Modulation* and *Antenna* adjustments are interdependent (i.e., adjusting one affects the other), you must now repeat Step 8 to verify that the *Antenna* adjustment produces the same maximum Vpp voltage reading on the oscilloscope as it did in Step 8. Alternate between the *Antenna* adjustment and the *Modulation* adjustment until they both meet the stated requirements.

14. The RSSI setting determines the threshold signal level of the CAD's receiver circuitry. It is set to its optimal value at the factory prior to shipment, and it is recommended that the value not be changed. (Increasing or decreasing the RSSI value decreases or increases the sensitivity of the receiver circuitry.)

15. Click on the **Save as Defaults** button to store the adjustment settings in FLASH memory on the CAD Control Board.

16. As a final test, place an initialized compatible SmartCard within the reader's range (remove the ISO antenna first) and click on the **RF Loopback Test** button. The following confirmation status should appear, verifying that the CAD and SmartCard communicated successfully.



◆ ***End of this Procedure*** ◆

4 INSTALLING CAD INTO TERMINAL

The CAD described in this manual has been designed specifically to be installed into an *ERG Transit Systems Model V3000 AFC Terminal*. The specific details on how to mount the CAD in the terminal and make electrical connections are provided by *ERG Transit Systems*. These details include the use of spacers and screws to secure the CAD in the terminal and which terminal cable to connect to the CAD's 16-pin parallel connector.

The information in this section is being provided to assist in adapting the CAD to other types of compatible enclosures, if desired.

Note *Refer to Appendix B for pin-out details of the CAD 16-pin parallel connector, and Appendix C for physical dimensions and clearances.*

Mounting Methods

Introduction

The CAD may be mounted in one of two ways:

- Stacked (method used in the *ERG Transit Systems Model V3000 AFC Terminal*)
- Separated

Each of these mounting methods is described below.

"Stacked" Mounting Method

The Control Board and the Antenna Board have been designed so that they may be stacked as shown on the facing page. The mounting holes line up with each other, and may be used with screws and spacers to secure the CAD to the terminal chassis.

Note that the two boards may be stacked so that the metal shields on the Control Board are either touching or not touching the metallic surface of the Antenna Board.

"Separated" Mounting Method

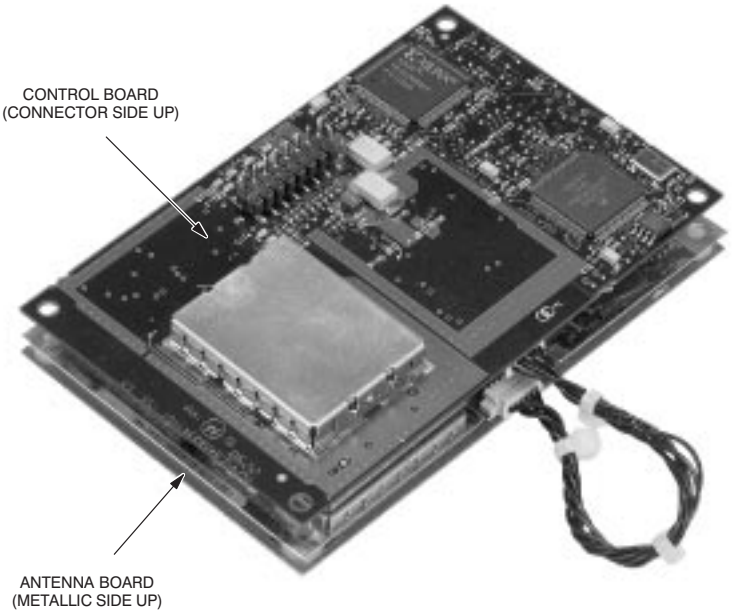
The 100 mm cable allows the Control Board and the Antenna Board to be separated to accommodate various mounting scenarios, as shown on the facing page.

Other Things You Should Know

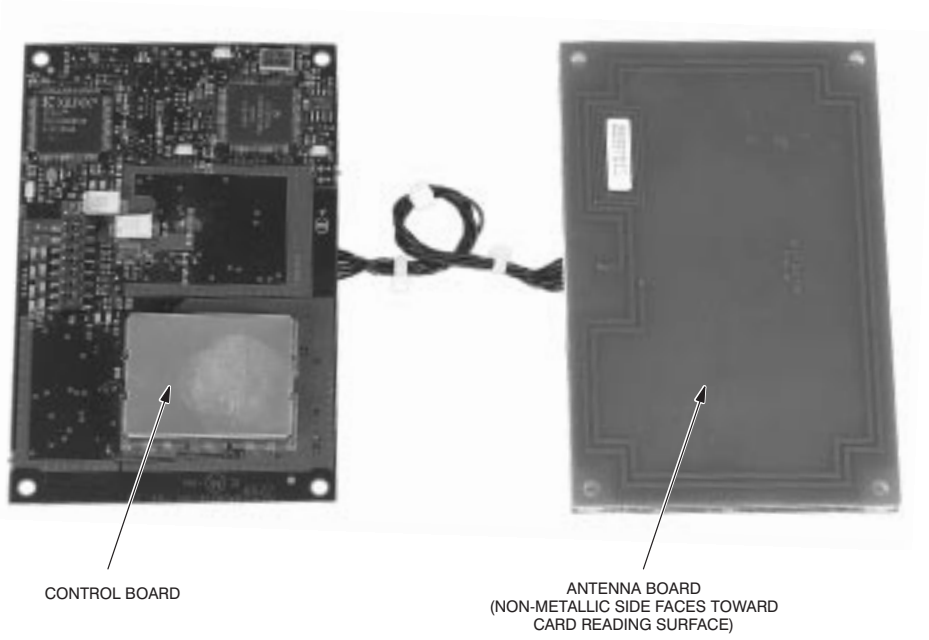
- The non-metallic side of the Antenna Board must face towards the card reading surface of the terminal.
- The Antenna Board should be mounted as close as possible to the Reader target area.
- The Antenna Board should be located at least 15 mm from any metallic materials.
- Route the multi-conductor interconnect cable away from any metallic materials. Also, dress and secure cable to prevent movement.

Mounting Methods

"Stacked" Mounting Method



"Separated" Mounting Method



5 FINAL CHECKOUT PROCEDURE

Once the CAD has been tuned and installed into the terminal, a final checkout procedure must be performed to ensure that the CAD can communicate with a compatible SmartCard. Once this final checkout has been performed, the terminal may be placed into service.

Required Equipment

The following hardware and software is required to perform the final checkout procedure:

- Compatible SmartCard (Model MV4000D)
- Powered terminal with CAD installed

Performing the Final Checkout Procedure

Place an active SmartCard (one that has been initialized and personalized for use with the particular terminal application) within reading distance and verify that the desired results are achieved. For example, for a transit application, the terminal should generate a receipt ticket (or some other verification, such as a ''beep" or light, that the transaction was successful).

Chapter 3 ▶ Troubleshooting

chapter contents

1 FAULT ISOLATION PROCEDURES

There are four basic techniques for isolating the CAD as the source of a faulty terminal:

- Verify dc power from the terminal (+12 V dc)
- Observe LED Indicator on the Control Board
- Perform the Self Test diagnostics checkout procedure
- Perform the Tuning Procedure

Verify DC Power

With the terminal turned on, the CAD should be receiving +12 V dc on pins 1 and 2 of the 16-pin parallel connector located on the Control Board (use pin 3 or 4 as ground). Verify that the voltage is present using a digital voltmeter. If the dc voltage is not present:

- Make sure the cable from the terminal is securely attached to the 16-pin connector on the Control Board.
- Troubleshoot the terminal to determine source of faulty +12 V dc.

Verify LED Indicator

A green LED is provided on the Control Board to provide a visual indication that the Control board has received dc power and has successfully performed its startup routine. If this LED is not lit after applying power:

- Verify +12 V dc power from the terminal (see above)
- Reload the CAD operating software into FLASH memory (refer to Appendix A in this manual)

Perform the Self Test Checkout Procedure

Run the Self Test Utility as described in Chapter 2.

Perform the CAD Tuning Procedure

Perform the CAD tuning procedure as described in Chapter 2.

2 RETURNING FAULTY CADS TO MOTOROLA

If you have performed the troubleshooting procedures on page 2 and have determined that the CAD is faulty, the entire CAD (Control Board, Antenna Board, and interconnect cable) must be returned to Motorola. The faulty CAD will be either repaired or replaced by Motorola service personnel. Contact the Motorola System Support Center at the contact numbers in the Foreword in this manual for shipping instructions.

Notes...

Chapter 4 ▶ Functional Theory of Operation

chapter contents

1 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the CAD circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the CAD in order to facilitate fault isolation. Refer to Figure 1 for a block diagram of the CAD.

Microprocessor Circuitry

Overview

The CAD uses a Motorola ColdFire MCF5204 microprocessor (μP) which serves as the main controller for the CAD. The microprocessor, running at a clock speed of 18.432 MHz (generated by an external clock circuit) controls the operation of the CAD as determined by the CAD software contained in the FLASH memory.

Address and Data Buses

The μP is equipped with a 32-bit address bus used to access the memory (FLASH and SRAM) and provide control (via memory mapping) for other circuitry in the CAD. A 16-bit data bus is used to transfer data to/from the μP, memory, and the AFE.

Terminal Interface

Four control lines from the μP control the operation of the Terminal Interface Circuitry to send/receive parallel data to/from the terminal via the 16-pin connector P8. Data lines D0−D7 of the μP Data Bus carry the data to/from the Terminal Interface Circuitry.

Reset Circuit

A Low +5V Detect circuit monitors the level of the +5V supply voltage and generates a reset signal if it falls below a threshold level. The reset signal is sent to the μP, the I/O Register, the AFE, and FLASH memory.

Non-Volatile Memory Circuitry

FLASH Memory

The CAD software resides in a 256k x 16 FLASH memory IC. The FLASH memory is accessed by the μP via the 32-bit Address Bus and the 16-bit Data Bus.

SRAM Memory

To supplement the μP's internal 512 bytes of internal SRAM, a 32k x 8 SRAM IC is provided.

AFE Circuitry

The Analog Front End (AFE) circuitry operates under control of the μP to provide a number of functions, as follows:

- Controls the power output to the antenna
- Modulates TX data and sends to card (via Antenna Board)
- Receives (via Antenna Board) RX data from card and provides demodulation

Supply Voltages Circuitry

The CAD Control Board contains on-board regulators and filtering circuitry to generate the various voltages required by the CAD circuitry. +12 V from the terminal (via connector P8) is used as the source to generate +5V and +5V_A supply voltages. Also, the variable PA_PWR supply voltage is generated and fed to the Power Amplifier (p/o AFE) to control the RF output power of the CAD.

Antenna Board

The Antenna Board consists of a printed circuit board (with traces that form the antenna), a ferrite plate (which magnetically shields the antenna from the Control Board), and a metal back plate (which electrically shields the antenna from the Control Board). The Antenna Board is connected to the Control Board by a 6-wire cable.

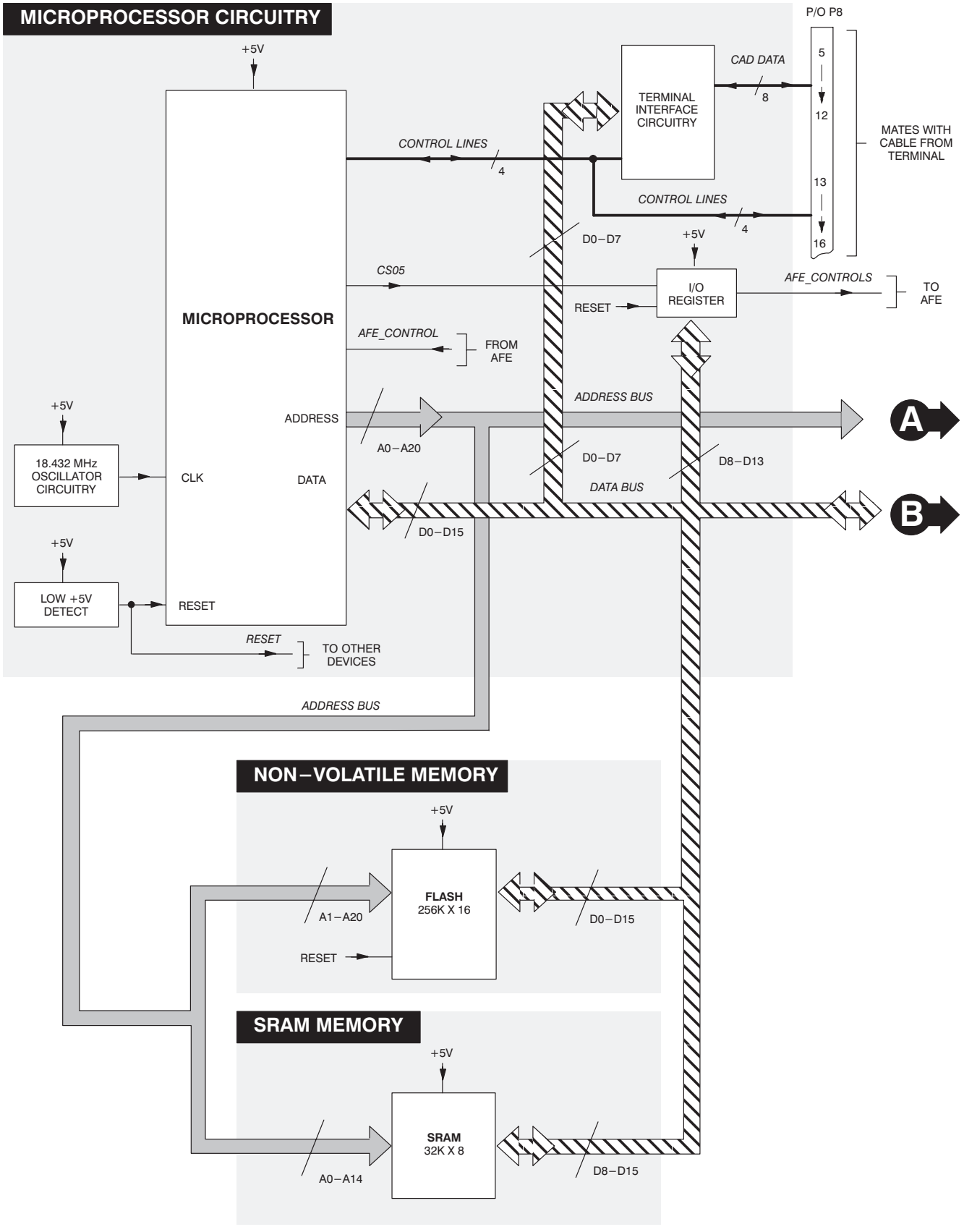


Figure 1. Card Access Device (CAD) Functional Block Diagram (1 of 2)

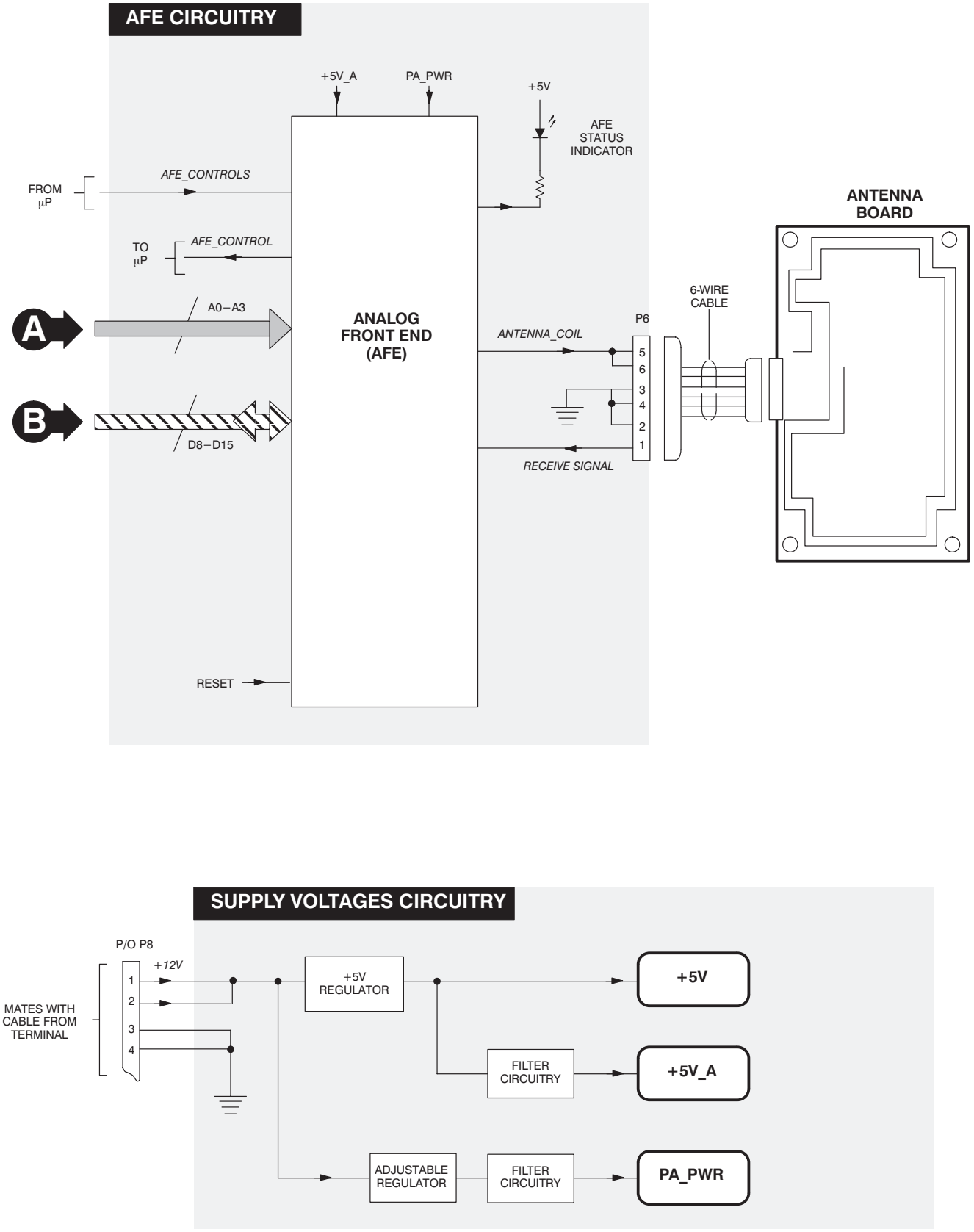


Figure 1. Card Access Device (CAD) Functional Block Diagram (2 of 2)

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Chapter 5 ▶ CAD Protocols and Commands

chapter contents

1 TERMINAL-TO-CAD COMMAND PROTOCOL

This section defines the structure of commands initiated by the terminal for transmission control and for specific control in asynchronous half-duplex transmission protocols. Block protocol type T=1 is used.

The command structure (shown below) consists of the following blocks:

- **prologue** field
- **information** field
- **epilogue** field

The prologue and epilogue fields are mandatory, and must be sent in every case. The information field is optional. The number of bytes of the information field is indicated by length (LEN) byte (part of the prologue field).

Command Structure

Prologue Field			Information Field	Epilogue Field
NAD	PCB	LEN	Inf	EDC
1 Byte	1 Byte	1 Byte	0 to 254 Bytes	2 Bytes

Prologue Field

NAD

The NAD byte in the Prologue field contains the block's target (DAD) and source (SAD) node addresses, as shown below.

NAD Byte Structure

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
x	x	x	x	–	–	–	–	DAD (Destination Node Address)
–	–	–	–	x	x	x	x	SAD (Source Node Address)

Prologue Field (continued)

PCB

The PCB byte in the Prologue field serves to control and supervise the transmission protocol. The PCB byte encodes first and foremost the block type, as well as supplementary data needed in this context. The PCB byte information for an I-block, an R-block, and an S-block are shown below.

PCB Byte Information for an I-Block

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
0	–	–	–	–	–	–	–	Signals I-block
0	N(S)	–	0	0	0	0	0	Send sequence number
0	–	x	0	0	0	0	0	Chaining (more data)

PCB Byte Information for an R-Block

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
1	0	0	–	–	–	–	–	Signals R-block
1	0	0	N(R)	–	–	–	–	Sequence Number
1	0	0	N(R)	0	0	0	0	No errors
1	0	0	N(R)	0	0	0	1	EDC or parity error
1	0	0	N(R)	0	0	1	0	Other errors

PCB Byte Information for an S-Block

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
1	1	–	–	–	–	–	–	Signals S-block
1	1	0	0	0	0	0	0	RESYNCH req = C0
1	1	1	0	0	0	0	0	RESYNCH ans = E0
1	1	0	0	0	0	1	0	Abort request = C2
1	1	1	0	0	0	1	0	Abort response = E2
1	1	0	0	0	0	1	1	WTX request = C3
1	1	1	0	0	0	1	1	WTX response = E3
1	1	x	x	x	x	x	x	RFU values used for the CAD management

Information Field (INF)

The presence of INF is optional. When present, INF conveys either application data in I-blocks for cards, miscellaneous data for the CAD or non-application control and status information in S-blocks.

In an S-block, this field is used for the management of the CAD. The CAD does not support the exhaustive list of S-Blocks defined in ISO 7816−3 T=1. However, the CAD supports Motorola proprietary definition of S-Blocks as commands for management.

R-blocks do not contain an INF field.

Epilogue Field

This field contains the error detection code (EDC) of the transmitted block. The protocol definition permits this to be either an LRC or a CRC. The LRC is calculated as the exclusive OR (XOR) of all the bytes starting with the NAD through the last byte of the information field, and is typically referred to simply as the checksum. For CRC see ISO 3309. The CAD uses the CRC.

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2 ANSWER TO RESET (ATR)

After cycling the power supply or software reboot, the CAD sends out an ATR on the link. The ATR is a data string, up to 33 bytes long, which contains various data relevant to the transmission protocol and to the card. The ATR's data string and data elements are defined and described in detail in ISO/IEC 7816−3. The structure of the ATR is the initial character TS followed by a variable number of subsequent characters in the following order: the format character T0, optionally the interface characters TAi, TBi, TCi, TDi and optionally the historical characters T1 T2 − TK and, conditionally, the check character TCK.

ATR Format

The basic ATR format consists of:

- **TS** — one byte, the initial character; specifies the conventions to code data bytes in all subsequent characters. There are two possible values of TS (ten consecutive bits from start to end and corresponding hexadecimal value). The CAD uses direct convention: (Z)AZZAZZZAAZ(Z) where logic level ONE is Z (LSB is first). It equals to "3B" when decoded by direct convention.
- **T0** — one byte, the format character; serves to indicate the subsequent "interface character" a bit field is used, from b5 to b8. It further contains the number of subsequent "historical characters," from b1 to b4.

T0 Byte Information

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
–	–	–	1	–	–	–	–	TA1 is transmitted
–	–	1	–	–	–	–	–	TB1 is transmitted
–	1	–	–	–	–	–	–	TC1 is transmitted
1	–	–	–	–	–	–	–	TD1 is transmitted
–	–	–	–	x	x	x	x	Number of historical characters

ATR Format (continued)

The four least significant bits of any interface byte TDi indicates a protocol type T, specifying rules to be used to process transmission protocols. When TD_1 is not transmitted, T=0 is used. TA_1 TB_1 TC_1 and TB_2 are the global interface bytes. These global interface bytes shall be interpreted in order to process any transmission protocol correctly.

The interface characters specify all transmission parameters of the current protocol. They are constructed from the bytes TAi, TB_i, TC_i, and TD_i (i =1, 2, 3...). TA_i, TB_i and TC_i indicate the protocol parameters. Their interpretation depends on the protocol type indicated by T in TD_{i-1}. TD_i indicates the protocol type T, as defined in [1] Section 6.1.4.3, and the presence of subsequent interface characters. The ATR transmission of these bytes is optional and may be omitted if appropriate.

TDi Byte Information

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
–	–	–	1	–	–	–	–	TA_{i+1} is transmitted
–	–	1	–	–	–	–	–	TB_{i+1} is transmitted
–	1	–	–	–	–	–	–	TC_{i+1} is transmitted
1	–	–	–	–	–	–	–	TD_{i+1} is transmitted
–	–	–	–	x	x	x	x	Protocol type for subsequent transmission

When TD_i is not transmitted, the default value of TA_{i+1} TB_{i+1} TC_{i+1} is null, indicating that no further interface characters TA_{i+1} TB_{i+1} TC_{i+1} TD_{i+1} will be transmitted. TA_1 to TC_3 convey information that shall be used during exchanges between the terminal and the CAD subsequent to the Answer to Reset. They indicate the values of the transmission control parameters F, D, I, P, and N, and the IFSC, block waiting time integer (BWI), and character waiting time integer (CWI) applicable to T=1 as defined in ISO/IEC 7816–3. The information contained in TA_1 to TC_1 and TC2 shall apply to all subsequent exchanges.

The historical characters, T1 T2 –TK, maximum 15 characters. It designates general information, for example, the CAD firmware version.

The value of check character TCK shall be such that the exclusive–ORing of all bytes from byte T0 to the last byte before the TCK.

3 CAD MANAGEMENT COMMANDS

Commands in proprietary S-Blocks supported by the CAD are:

- RF POWER CONTROL: control of the RF field parameters (page 5−10)
- SLEEP: put the CAD in low power mode (page 5−12)
- DOWNLOADING: put the CAD in downloading mode (page 5−14)
- ERROR REPORT: the CAD indicates an Hardware error (page 5−16)
- POLL: put the CAD in card registration mode (page 5−18)
- ANSWER TO POLL: the CAD sends the parameters of a card detected (page 5−20)
- DETECT CARD: put the CAD in card detection mode (page 5−22)
- CARD PRESENCE: the CAD sends to the terminal the result of the DETECT CARD command. (page 5−24)
- REBOOT: forces the CAD to reset (page 5−25)

Commands issued from the Terminal to the CAD are called "Requests."
Commands issued from the CAD to the Terminal are called "Responses."

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RF POWER CONTROL

RF POWER CONTROL request

Description

This command allows the terminal to control the RF field power. The four options of the PCON byte can turn on the 13.56MHz carrier, turn off the carrier, increase the power of the RF field and to decrease the power of the RF field.

Direction

Terminal to CAD

Size

6 Bytes

Format

See below

RF POWER CONTROL Request Format

NAD	PCB	LEN	PCON	CRC1	CRC2
0x11	0xC5	1	(see below)	(see below)	(see below)

PCON Values	Meaning	CRC1 Values	CRC2 Values
0x00	Power On	0x3B	0x09
0x01	Power Off	0xB2	0x18
0x02	Decrease Power	0x29	0x2A
0x03	Increase Power	0xA0	0x3B
Other Values	Forbidden	—	—

RF POWER CONTROL (continued)

RF POWER CONTROL response

Description

The response frame is an acknowledgement of the previous command, indicating that the command was properly received and has been executed.

Direction

CAD to Terminal

Size

5 Bytes

Format

See below

RF POWER CONTROL Response Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xE5	0	0xA4	0x8E

SLEEP

SLEEP request

Description

This command switches the CAD board to a low-power mode. It sequentially turns off the RF power, stops watchdog timer, unmask only the UART (serial CAD) or STROBE (parallel CAD) interrupt and switches to the STOP mode of the ColdFire. While no interrupt from the UART (or STROBE) is received (any frame from the terminal), the CAD stays in this mode. Any UART (or STROBE) interrupt wakes the CAD processor core, turns on the RF power and switches to the state of frame reception.

Direction

Terminal to CAD

Size

5 Bytes

Format

See below

SLEEP Request Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xC8	0	0xEF	0x1D

SLEEP response

Description

The response frame is an acknowledgment of the previous command that indicates that the command was properly received and is ready to be executed. This response is sent before the CAD switches to SLEEP state.

Direction

CAD to Terminal

Size

5 Bytes

Format

See below

SLEEP Response Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xE8	0	0xDC	0x3E

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DOWNLOADING

DOWNLOADING request

Description

This command makes the CAD switch to downloading mode. It is only accepted as the first command after the CAD reboots. The code of the Parameters 1 & 2, processor and FPGA can be downloaded by selecting the TARGET byte 0x00.

This command must be sent both at the beginning and at the end of the downloading sequence. At the end of the downloading sequence, this command confirms that the downloading sequence is correctly complete and provokes the reset of the CAD processor. The TARGET field of this last block must be identical to the TARGET field of the previous DOWNLOADING command.

Direction

Terminal to CAD

Size

6 Bytes

Format

See below

DOWNLOADING Request Format

NAD	PCB	LEN	TARGET	CRC1	CRC2
0x11	0xC6	1	(see below)	(see below)	(see below)

TARGET Values	Meaning	CRC1 Values	CRC2 Values
0x00	Parameters 1-2, MCU, and FPGA Code	0x5F	0xE6
0x01	All FLASH Code (including Boot Block)	0xD6	0xF7
Other Values	RFU	RFU	RFU

DOWNLOADING (continued)

DOWNLOADING response

Description

The response frame is an acknowledgment of the previous command that indicates that the command was properly received and is ready to be executed.

Direction

CAD to Terminal

Size

5 Bytes

Format

See below

DOWNLOADING Response Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xE6	0	0xCC	0xA4

ERROR REPORT

ERROR REPORT response

Description

The CAD sends this command to the terminal if the CAD software has detected an error during the test sequence at boot up. The tests executed by the CAD at boot−up are the verification of the processor code checksum, the verification of the FPGA code and a UART test (serial CAD only) in loopback mode. If the CAD detects any of these errors, it immediately sends this frame to the terminal after the ATR frame (for Serial CADs) or after the Error Report Request (for Parallel CADs).

Direction

CAD to Terminal

Size

6 Bytes

Format

See below

ERROR REPORT Request Format

NAD	PCB	LEN	ERR	CRC1	CRC2
0x11	0xC7	1	(see below)	(see below)	(see below)

ERR Values	Meaning	CRC1 Values	CRC2 Values
0x00	No Error	0x83	0xBC
0x01	Code Checksum Error	0x0A	0xAD
0x02	FPGA Code Error	0x91	0x9F
0x04	UART Initialization Error (serial CAD only)	0xA7	0xFA
0x08	SRAM Error	0xCB	0x30
Other Values	RFU	RFU	RFU

ERROR REPORT (continued)

ERROR REPORT request

Description

For Serial CADs — There is no ERROR REPORT request.

For Parallel CADs — The Terminal sends this command to the Parallel CAD to determine if the CAD software has detected an error during the test sequence at boot up.

Direction

Terminal to CAD

Size

5 Bytes

Format

See below

ERROR REPORT Request Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xE7	0	0x14	0xBD

POLL

POLL request

Description

This command makes the CAD switch to the card detection/anti−collision sequence. The card must be out of the RF field before sending a *Poll request*.

The STRAT byte supports two options that order the CAD to detect all cards (Long Poll) or the first card (Quick Poll) in the RF field.
As the CAD manages the attribution of the NAD for the cards detected in the field, it reserves NAD values that are already in use and gives free NAD values to a new card that is detected. But the CAD has no information about the transactions between the terminal and the card(s). Thus, when the terminal has completed all the transactions with the card(s) registered, it may indicate to the CAD that the busy values can be freed or not by setting the appropriate value in the ERASE field.

The TYPE byte of this command indicates to the CAD which type of application of contactless card in the field must be selected.

Direction

Terminal to CAD

Size

8 Bytes

Format

See below

POLL Request Format

NAD	PCB	LEN	STRAT	ERASE	TYPE	CRC1	CRC2
0x11	0xD0	3	(see below)	(see below)	(see below)	xx	xx

STRAT Values	Meaning	ERASE Values	Meaning
0x00	Quick Poll	0x00	Do not erase NAD table
0x01	Long Poll	0x01	Erase NAD table
Other Values	RFU	Other Values	Forbidden

TYPE Values	Meaning	TYPE Values	Meaning
0x00	All	0x06	Multimedia
0x01	Transport	0x07	Gaming
0x02	Financial	0x08	Data Storage
0x03	Identification	0x09−0x7E	RFU
0x04	Telecommunication	0x7F	All previous
0x05	Medical	0x80−0xFF	Proprietary

POLL (continued)

POLL response

Description

The response frame is an acknowledgment of the previous command that indicates that the command was properly received and is ready to be executed.

Direction

CAD to Terminal

Size

5 Bytes

Format

See below

POLL Response Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xF0	0	0x8D	0x65

ANSWER TO POLL

ANSWER TO POLL request

There is no ANSWER TO POLL request.

ANSWER TO POLL response

Description

When a card is successfully registered in the CAD (the card answered correctly to the REQUEST SLOT MARKER and ATTRIB frames), the CAD sends this frame to the terminal to indicate that a new card is to be registered. The ATPoll request frame transports all necessary information about the card and the card−terminal link.

The NEW NAD byte is the value of the NAD that will be used by the terminal and the card during the transaction. This NAD is ISO 7816−3 T=1 compliant. The terminal must use the value received in the ATPoll command to sent data to the card, without inverting the most significant and the least significant nibble of the byte. Once the Terminal sends a command with the new NAD (other than 0x11), the CAD sets the data transmission to Pipeline Mode that allows the Terminal to directly communicate to the card (and visa versa). This process may continue until the CAD receives its own NAD (0x11) from the Terminal.

The four−byte PUPI field identifies formally the card. The terminal may use it to detect non−valid cards.

The HB field may be n bytes long (0−15) and is the exact image of the Historical Bytes field of the card ATQ frame.

Direction

CAD to Terminal

Size

12+n Bytes

Format

See below

ANSWER TO POLL Response Format

NAD	PCB	LEN	DATA from the ATQ					CRC1	CRC2
0x11	0xD1	7 +n*	NEW NAD	PUPI	TC2	TA3	HB	xx	xx

* n = number of Historical Bytes (HB)

DATA from ATQ Values	Meaning
NEW NAD	NAD chosen by the CAD for the new Terminal-Card link
PUPI	4-byte Card Identifier (Pseudo Unique PICC Identifier)
TC2	POW (Minimum and Maximum Power Level
TA3	LEN (Maximum Block Length)
HB	Historical Bytes from the ATQ frame

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DETECT CARD

DETECT CARD request

Description

After a Quick Poll command, the DETECT CARD command may be sent by the terminal to know if there are additional cards in non−application phase into the RF field. After this command, the CAD sends a REQUEST command parameterized with 1 slot through the RF field. Consequently, if one or more additional cards are present in the RF field, it must answer to the REQUEST command. The card which is communicating with the Terminal will not answer to the REQUEST if it has received a DESELECT command (see ISO/IEC 14443−3).

The TYPE byte of this command indicates to the CAD which type of application of contactless card in the field must be detected.

Whatever is the result of the detection (nothing, a collision or a correct answer), the CAD uses the CARD PRESENCE command to indicate the result of this detection sequence.

Note *Since this command is to be sent after a Quick Poll command, do not try to send this command under any other circumstances (like immediately after reboot).*

Direction

Terminal to CAD

Size

6 Bytes

Format

See below

DETECT CARD Request Format

NAD	PCB	LEN	TYPE	CRC1	CRC2
0x11	0xD3	1	(see below)	(see below)	(see below)

TYPE Values	Meaning	CRC1 Values	CRC2 Values
0x00	All	0x77	0x5A
0x01	Transport	0xFE	0x4B
0x02	Financial	0x65	0x79
0x03	Identification	0xEC	0x68
0x04	Telecommunication	0x53	0x1C
0x05	Medical	0xDA	0x0D
0x06	Multimedia	0x41	0x3F
0x07	Gaming	0xC8	0x2E
0x08	Data Storage	0x3F	0xD6
0x09−0x7E	RFU	RFU	RFU
0x7F	All Previous	0x07	0xD1
0x80−0xFF	Proprietary	Proprietary	Proprietary

DETECT CARD (continued)

DETECT CARD response

There is no response for the DETECT CARD command.

CARD PRESENCE

CARD PRESENCE request

There is no CARD PRESENCE request.

CARD PRESENCE response

Description

The CAD sends this frame to the terminal as a result of the card detection sequence initiated by the DETECT CARD command.

The PRES byte of the command indicates if something new is detected or not.

Direction

CAD to Terminal

Size

6 Bytes

Format

See below

CARD PRESENCE Response Format

NAD	PCB	LEN	PRES	CRC1	CRC2
0x11	0xD4	1	(see below)	(see below)	(see below)

PRES Values	Meaning	CRC1 Values	CRC2 Values
0x00	No Card	0x72	0xD6
0x01	Card(s) Detected	0xFB	0xC7
Other Values	Forbidden	—	—

REBOOT

REBOOT request

Description

This command makes the CAD processor reset. After this command is executed the CAD board is reset and any configuration different from the CAD default configuration is lost.

Direction

Terminal to CAD

Size

5 Bytes

Format

See below

REBOOT Request Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xD2	0	0x0E	0x75

REBOOT response

Description

The response frame is an acknowledgment of the previous command that indicates that the command was properly received and is ready to be executed.

Direction

CAD to Terminal

Size

5 Bytes

Format

See below

REBOOT Response Format

NAD	PCB	LEN	CRC1	CRC2
0x11	0xF2	0	0x3D	0x56

BREAK CHARACTER

BREAK CHARACTER request

Description

A break character makes the CAD processor reset. After this character is sent, the CAD board is reset (after 100 msec delay) and any configuration different from the CAD default configuration is lost.

Direction

Terminal to CAD

Size

1 Bytes

Format

All the bits are set to 0. The Stop Bit is included.

BREAK CHARACTER response

Description

There is no response to the BREAK CHARACTER command.

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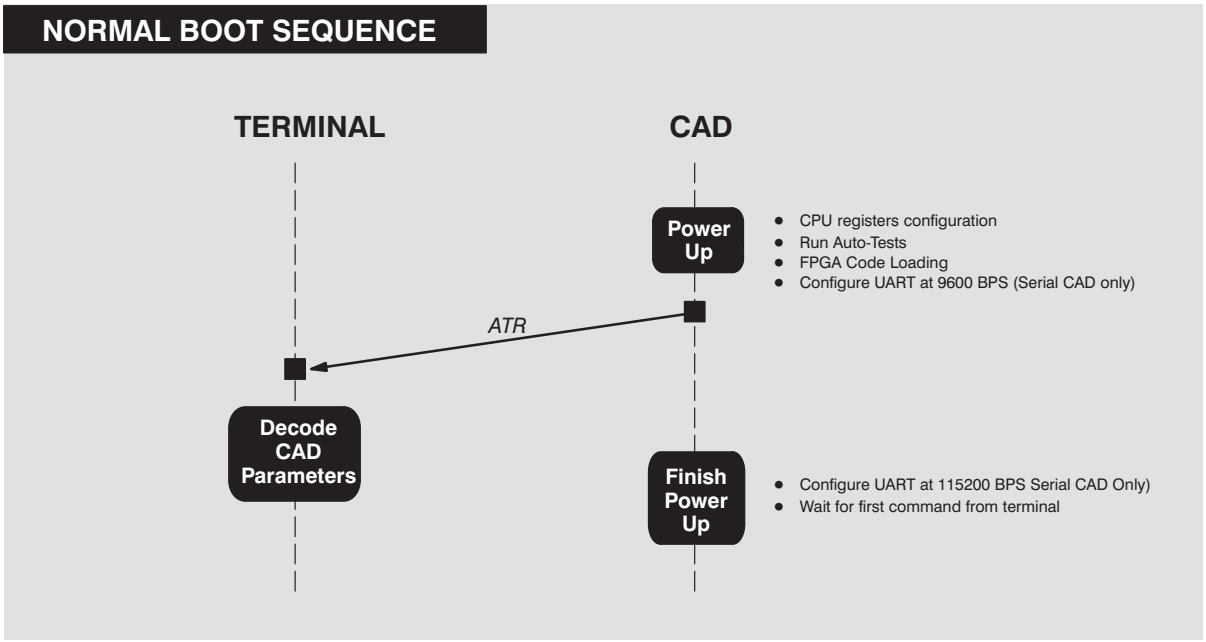
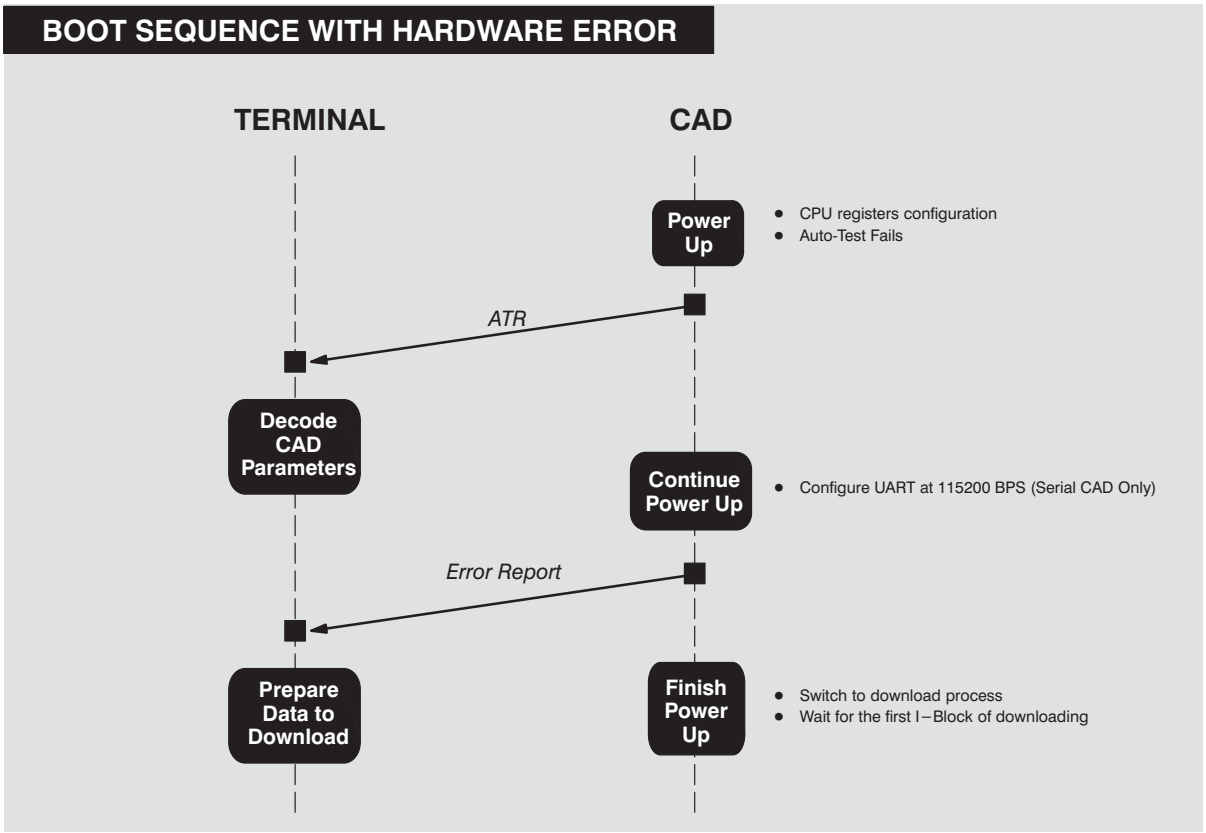
4 COMMAND SEQUENCES

The illustrations on the next few pages show the command sequences between the Terminal, CAD, and Card for the following scenarios:

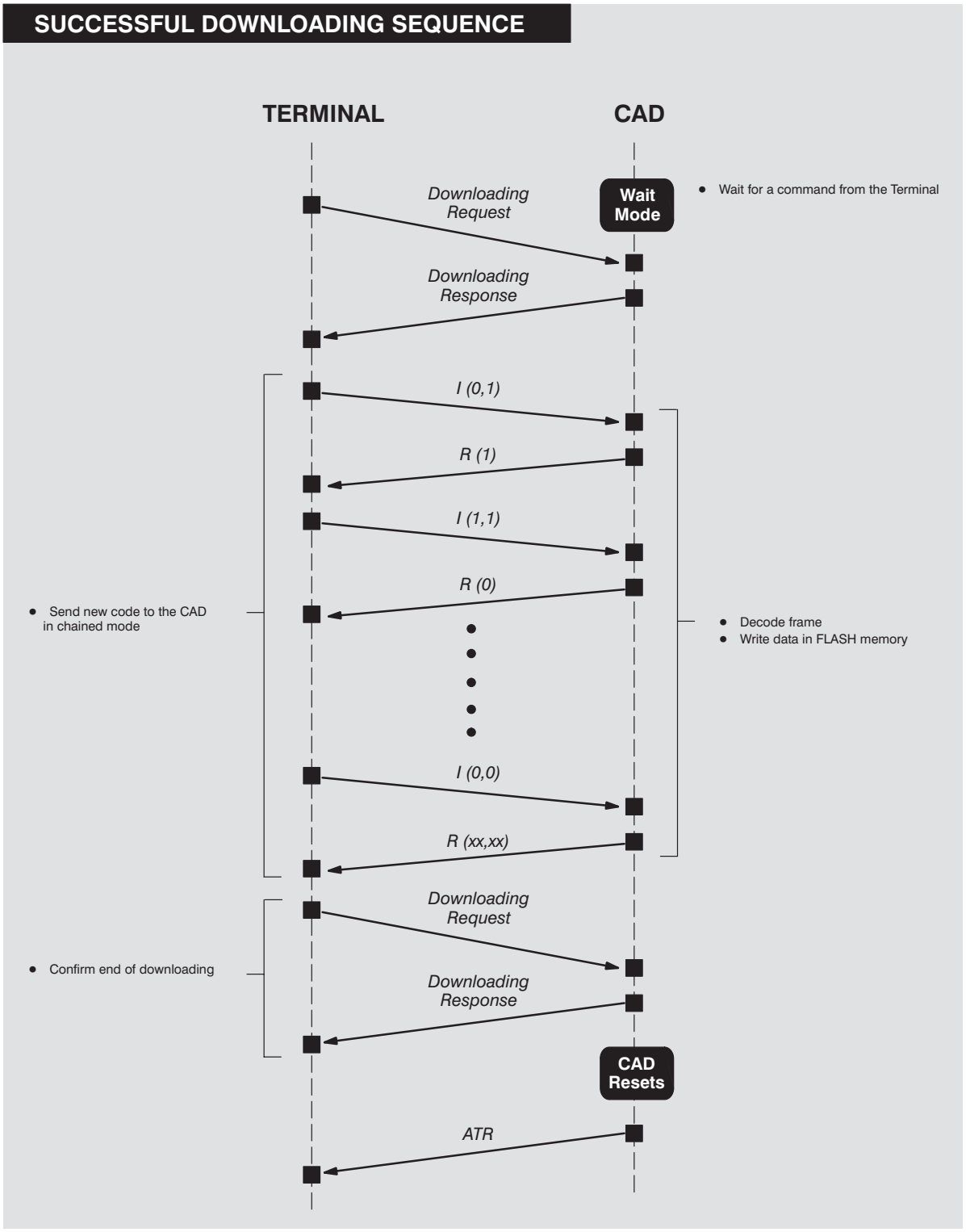
- Boot Sequence
- Downloading Sequence
- Quick Poll Sequence
- Long Poll Sequence
- Detect Card Sequence
- RF Power Control Sequence
- Sleep Sequence
- Reboot Sequence

Boot Sequence



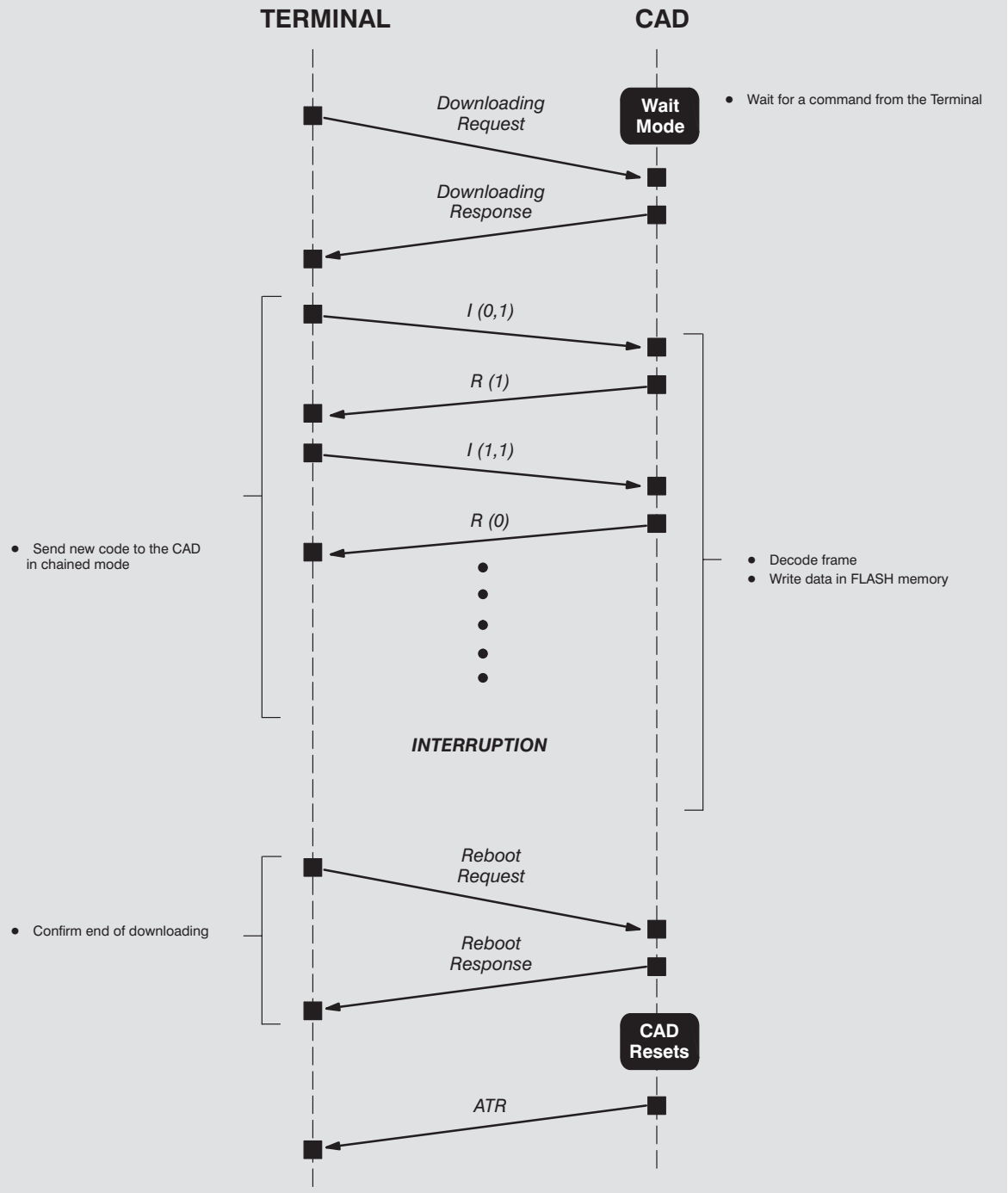


Downloading Sequence



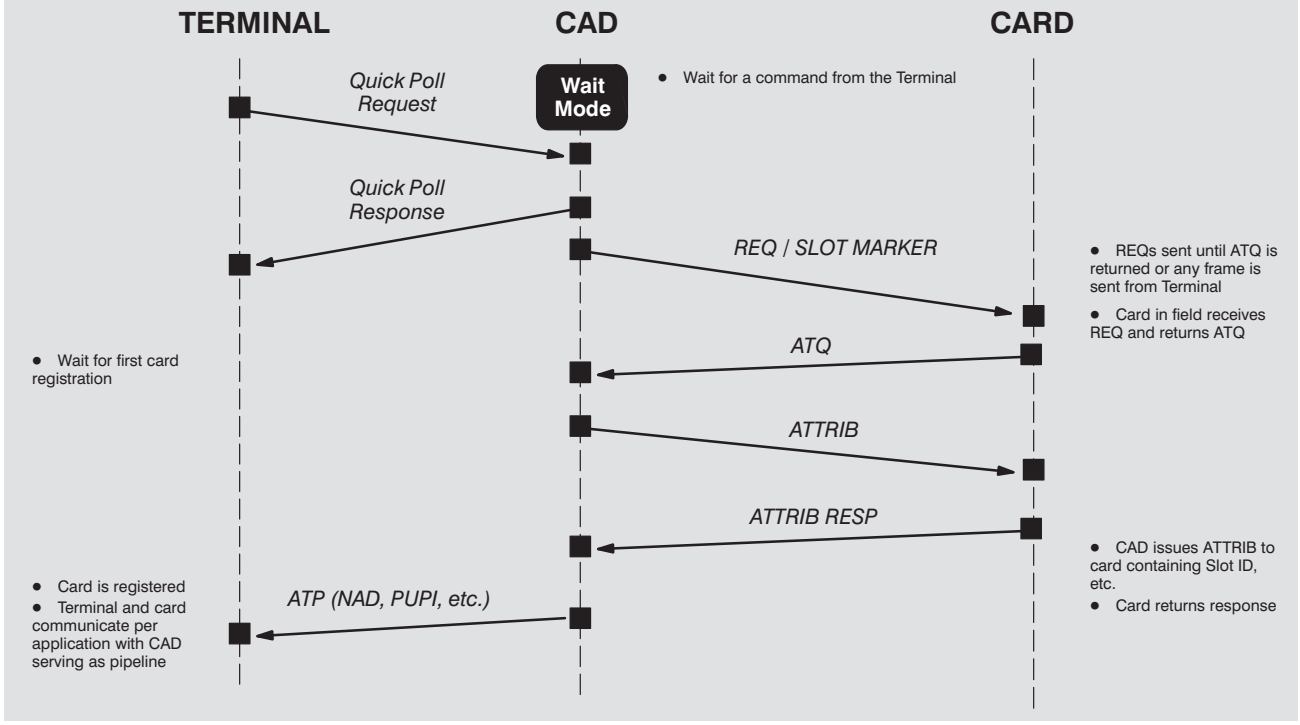
Downloading Sequence (continued)

INTERRUPTED DOWNLOADING SEQUENCE

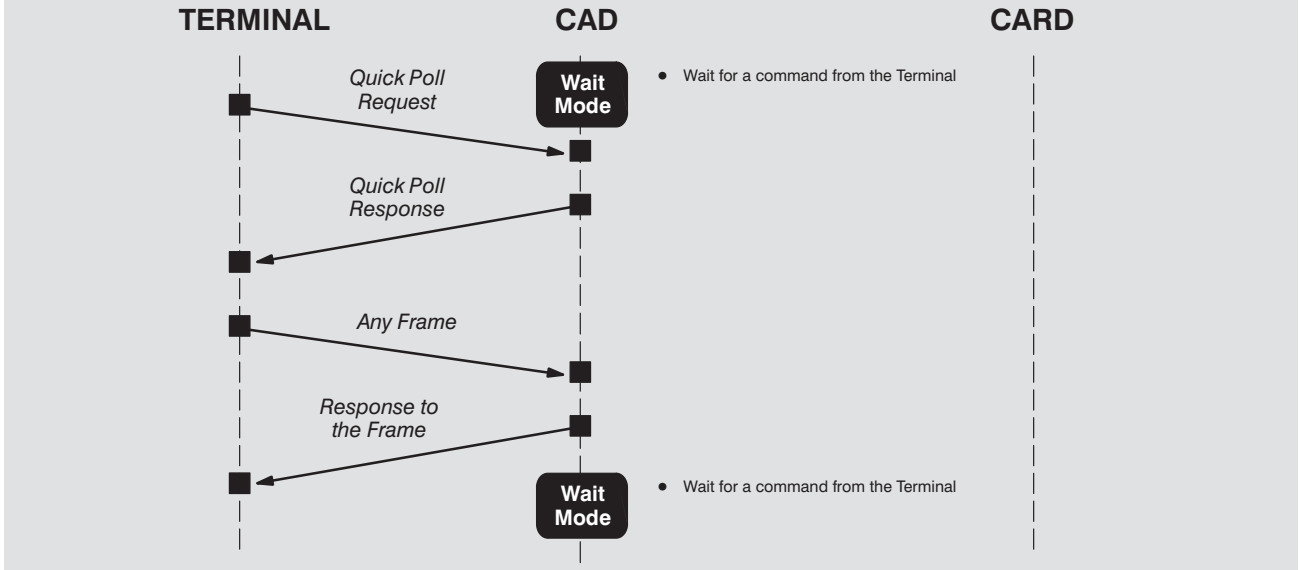


Quick Poll Sequence

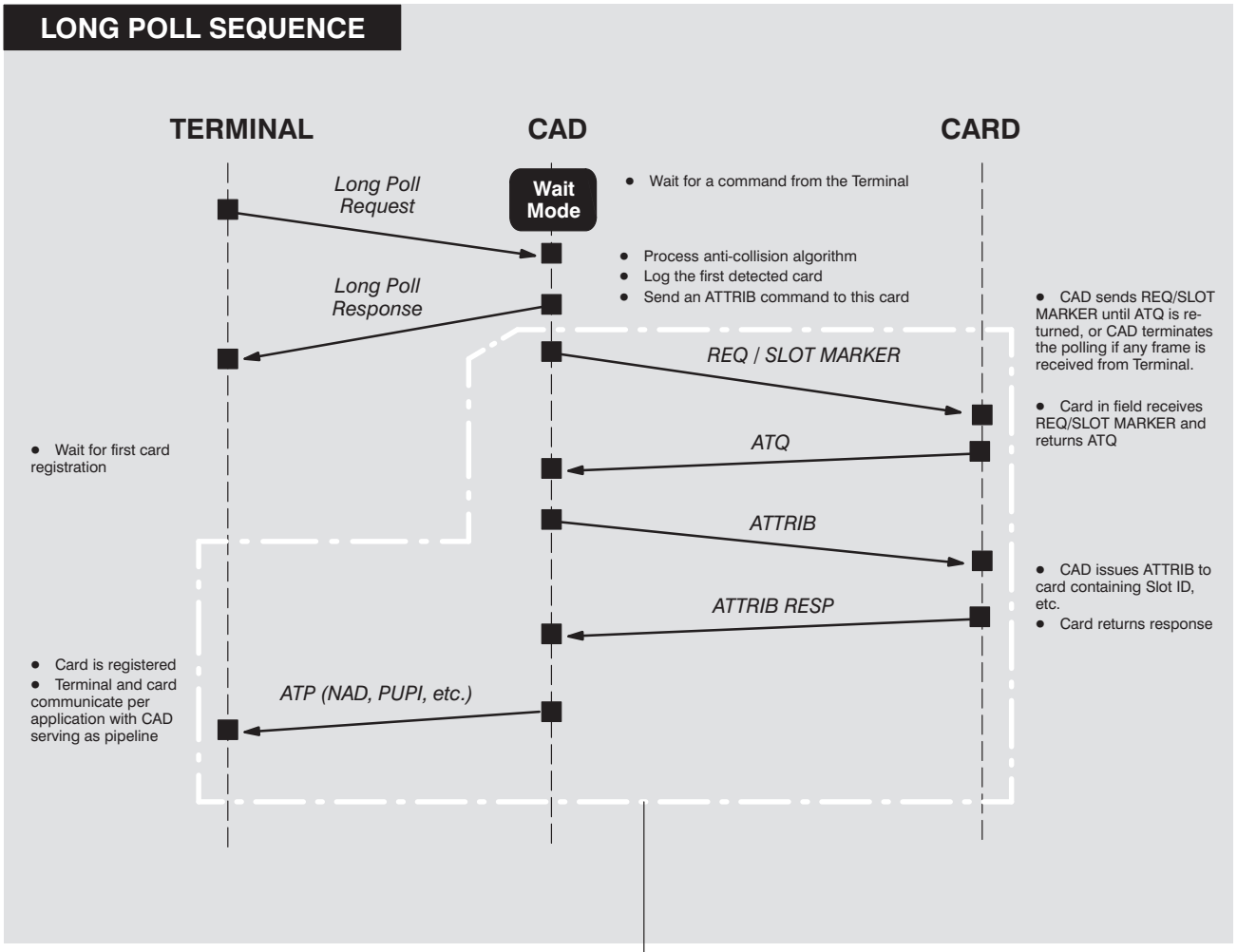
NORMAL QUICK POLL SEQUENCE



INTERRUPTED QUICK POLL SEQUENCE

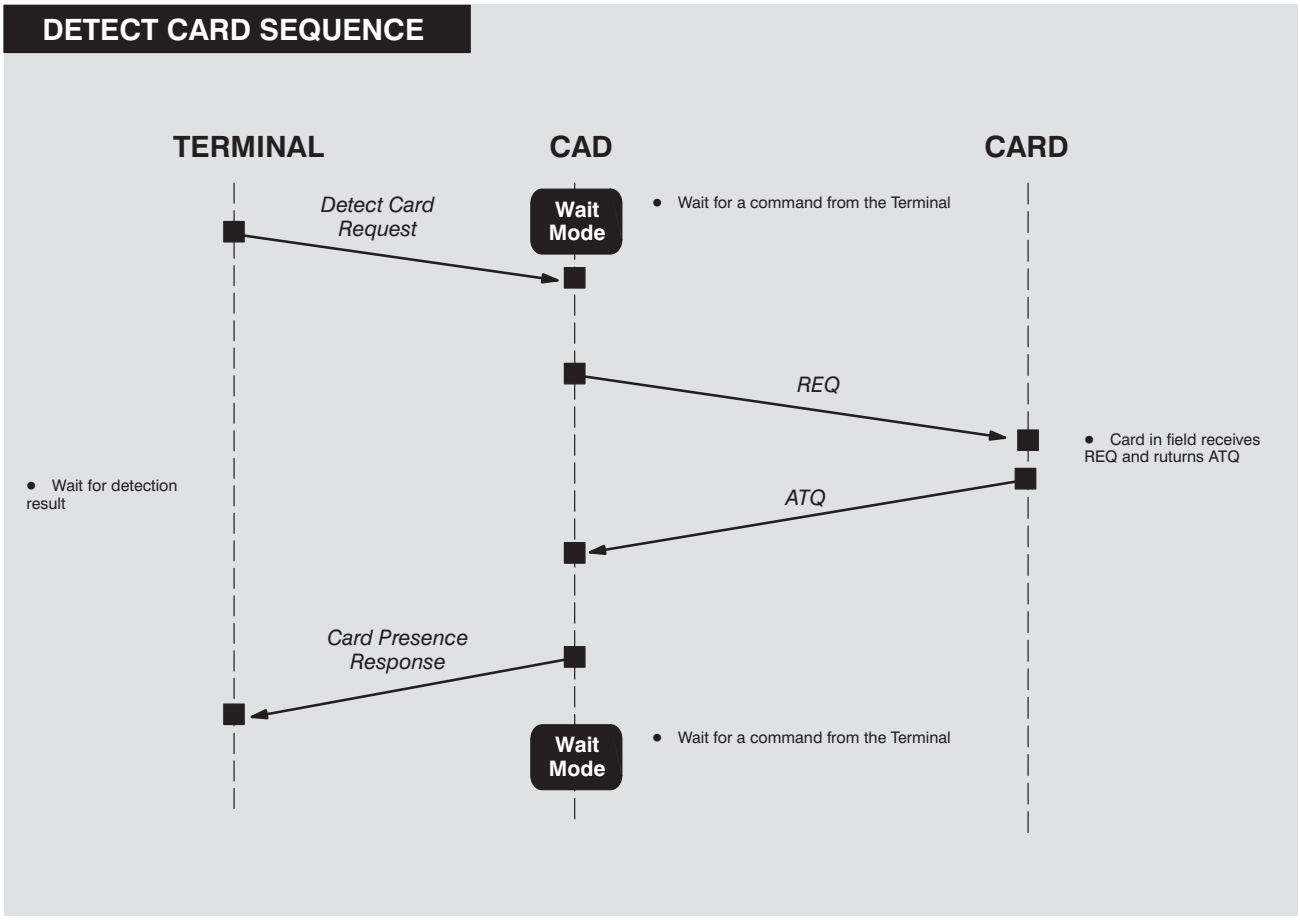


Long Poll Sequence

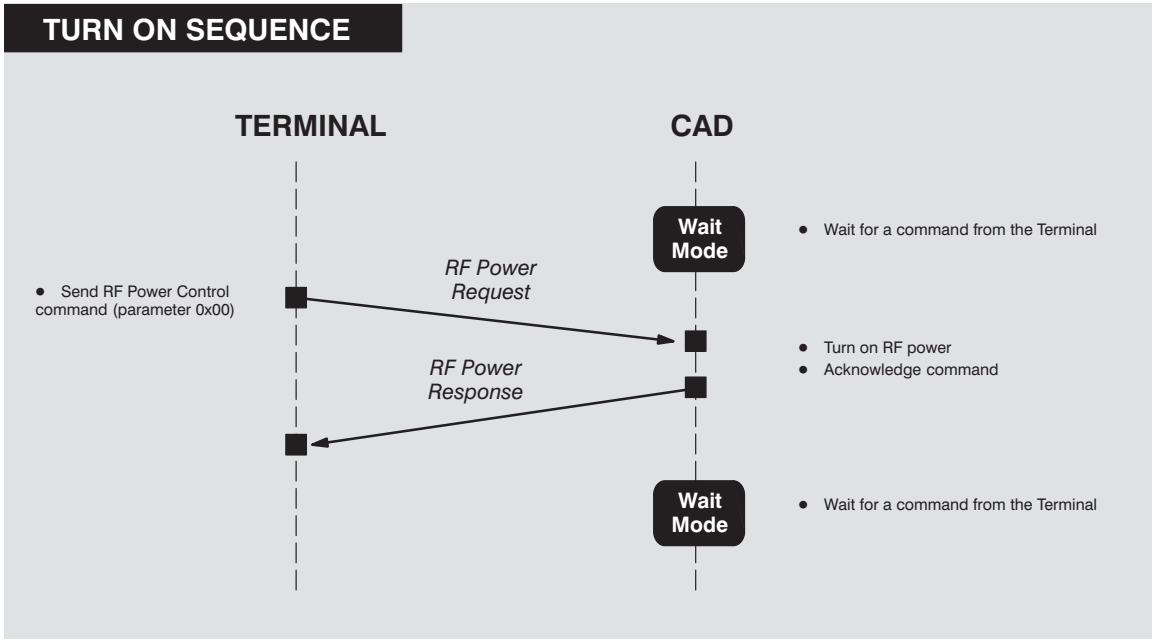


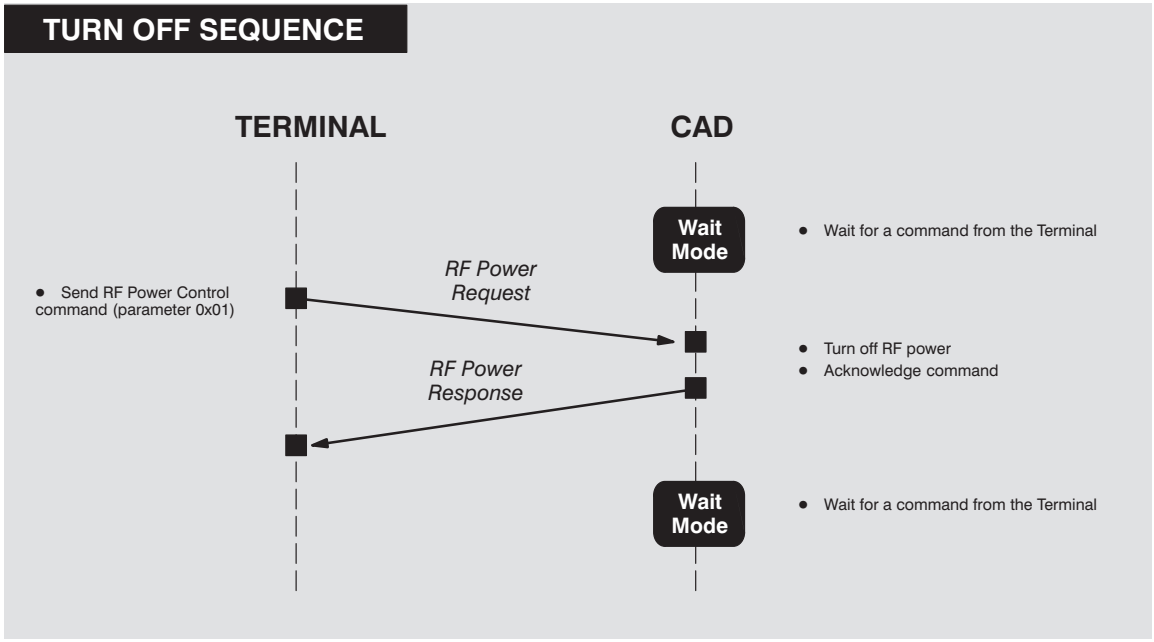
This sequence may be repeated up to four times (should four cards be presented at the same time).

Detect Card Sequence



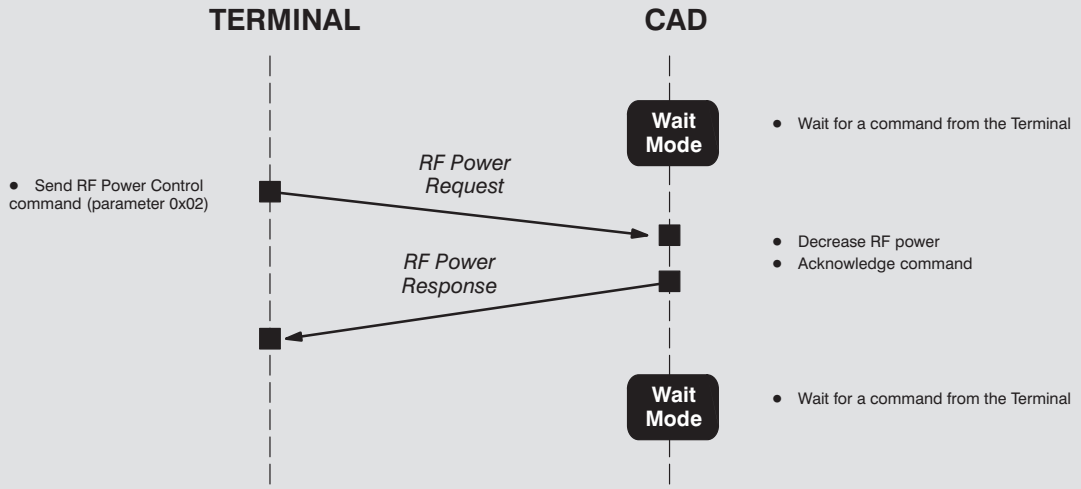
RF Power Control Sequence



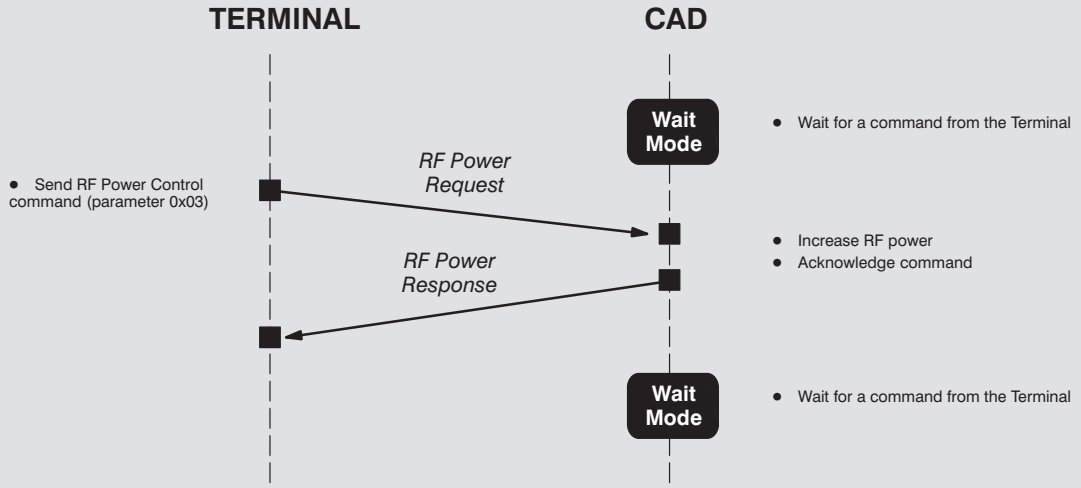


RF Power Control Sequence (continued)

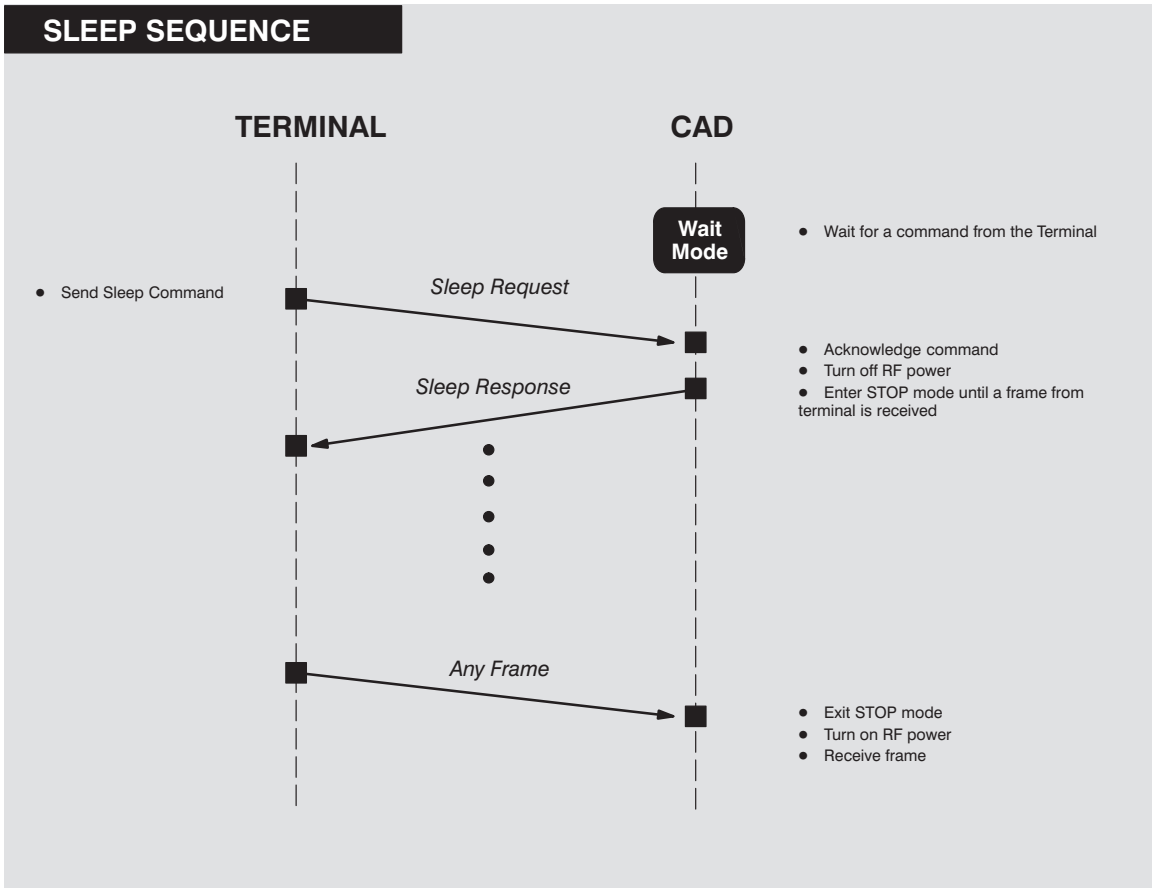
DECREASE POWER SEQUENCE



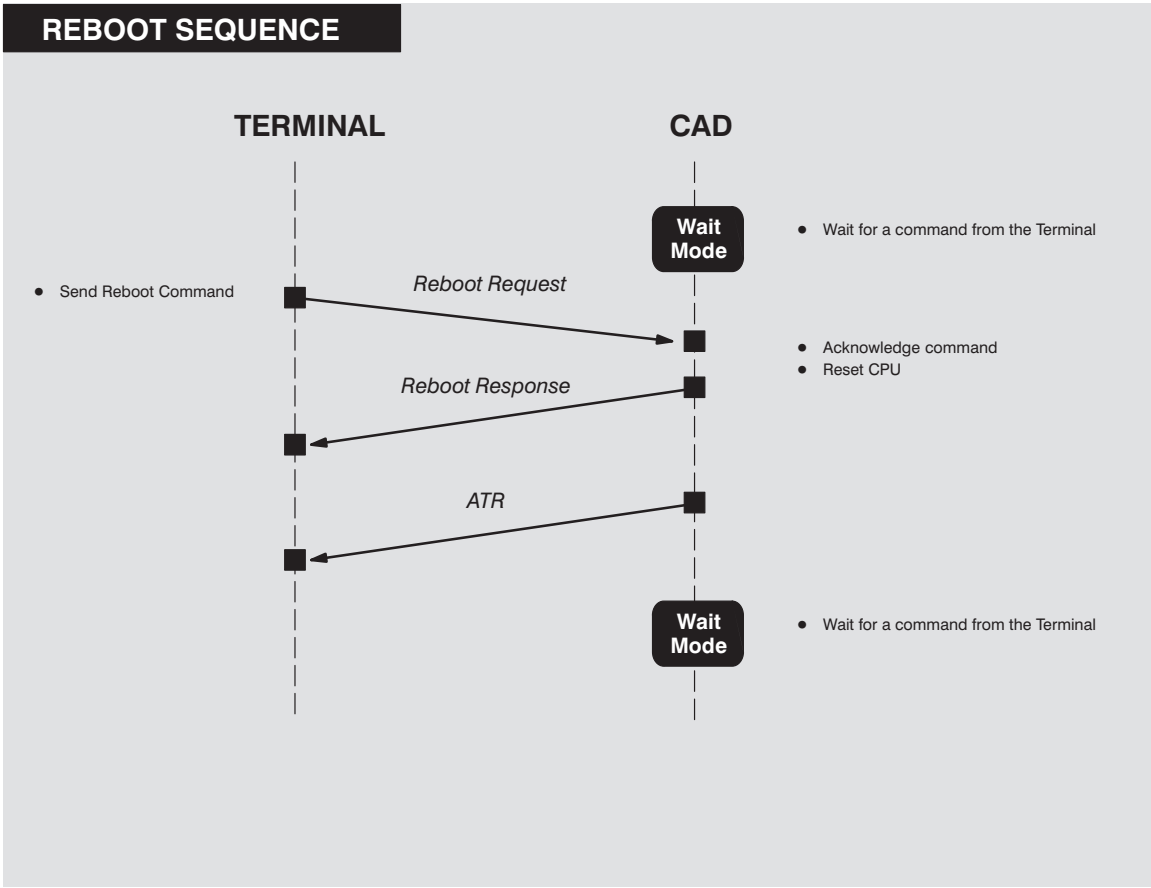
INCREASE POWER SEQUENCE



Sleep Sequence



Reboot Sequence



Appendix A ▶ Performing FLASH Upgrades

chapter contents

1 FLASH UPGRADE PROCEDURE

Operating software for the CAD is stored in FLASH memory on the Control Board. The software may be upgraded (or reinstalled) by using the Firmware Download utility included as part of the *CADTools* software program (provided with the Model T6439A Parallel CAD Installation Kit).

Preparing for Upgrade Procedure

Locating CAD Operating Software

The upgrade process installs CAD operating software (stored on the PC hard disk or floppy diskette) into FLASH memory on the CAD Control Board. Before you begin the upgrade procedure, make sure you have available the desired version of CAD software. It is recommended that you copy this software into the following location on the PC hard disk:

C:\Program Files\CADTools

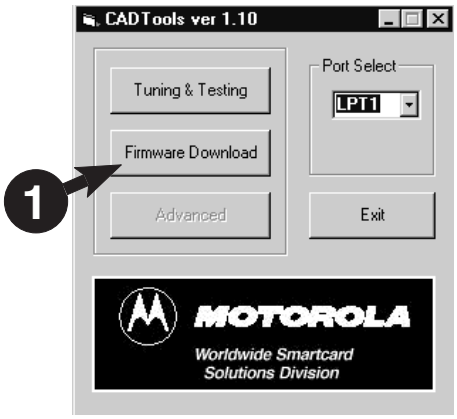
(Since the *Firmware Upgrade* utility automatically looks in this directory first for CAD operating software, locating the software here will streamline the process as well as provide one central directory in which to store all of your CAD operating software versions.)

Setting Up the CAD and PC

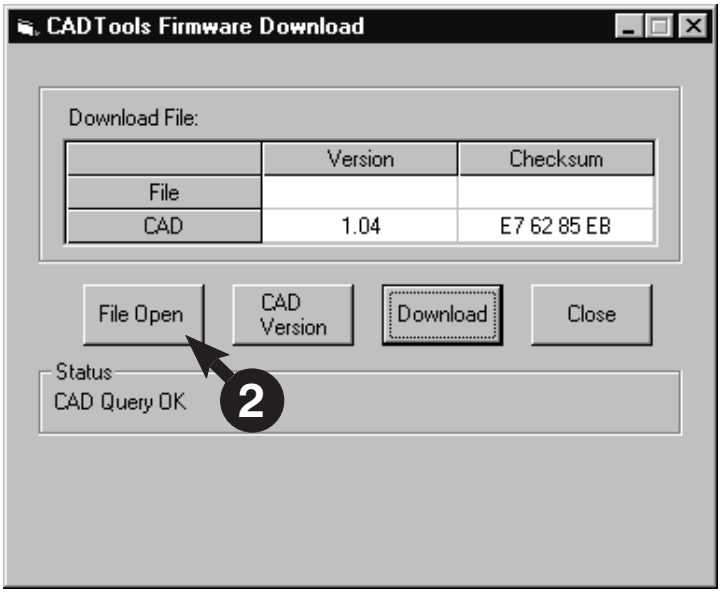
Connect the CAD to the PC and launch the CADTools program as described in *Launching the CADTools Software* on page 2−5 of this manual.

Performing FLASH Upgrade Procedure

1. With the CAD connected to the PC and the *CADTools* program running, click on the **Firmware Download** button.



2. The following *CADTools Firmware Download* main screen will appear, displaying the version of CAD operating software currently in FLASH memory in the CAD. Click on the **File Open** button.

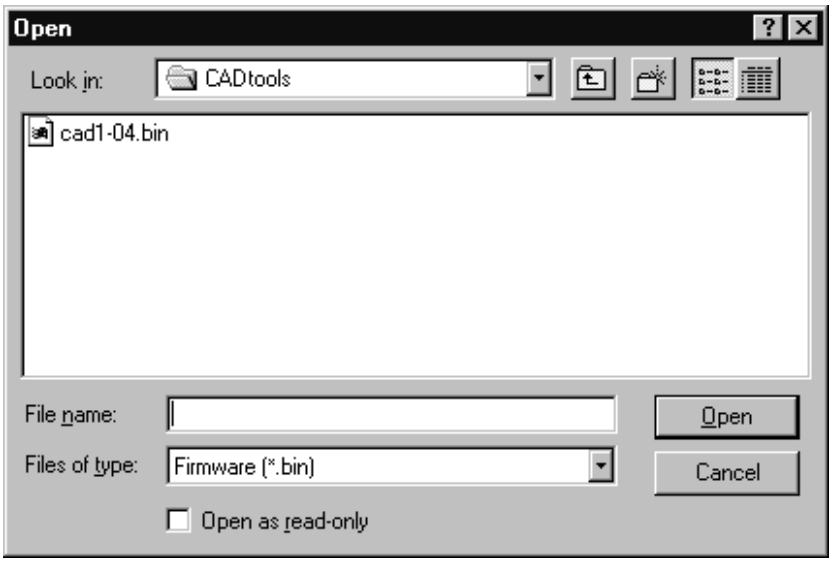


continued on next page

Performing FLASH Upgrade Procedure (continued)

Note *You may have received the CAD operating software via diskette, CD-ROM, email, FTP, or other file transfer means. It is recommended that you store all software files in the default directory (i.e.,* ***C:\Program Files\CADtools****) so that they will appear in the* ***Open*** *screen. Otherwise, you will have to navigate to the file location to select the desired file.*

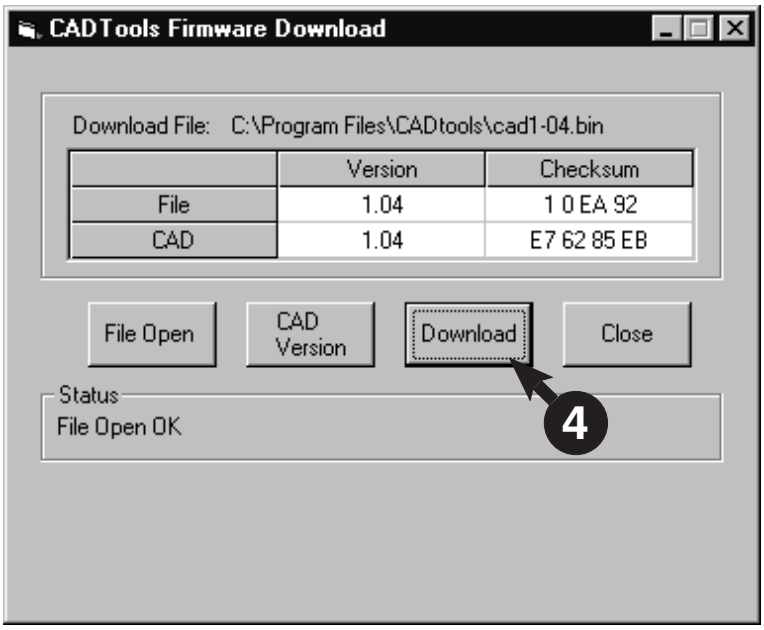
3. The following *Open* screen will appear. You will use this screen to locate the file containing the CAD operating software you wish to download to the CAD. Select the desired file and click on **Open**.



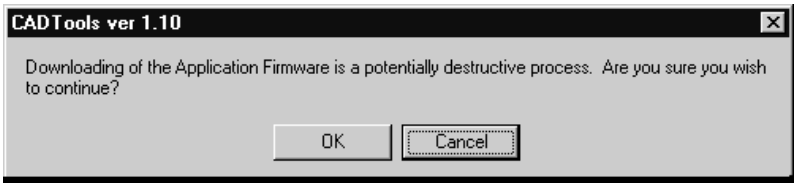
continued on next page

Performing FLASH Upgrade Procedure (continued)

4. The following screen will appear, displaying the version of CAD operating software currently in FLASH memory in the CAD **and** the version of the operating software contained in the file you selected in the previous step. Verify that this is the version you wish to download to the CAD, then click on the **Download** button.



5. A warning message will appear. Click on **OK**.



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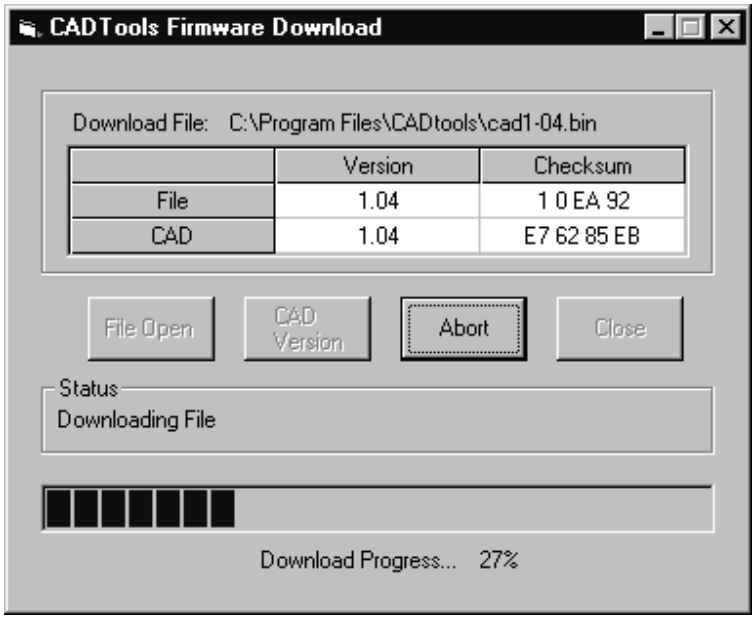
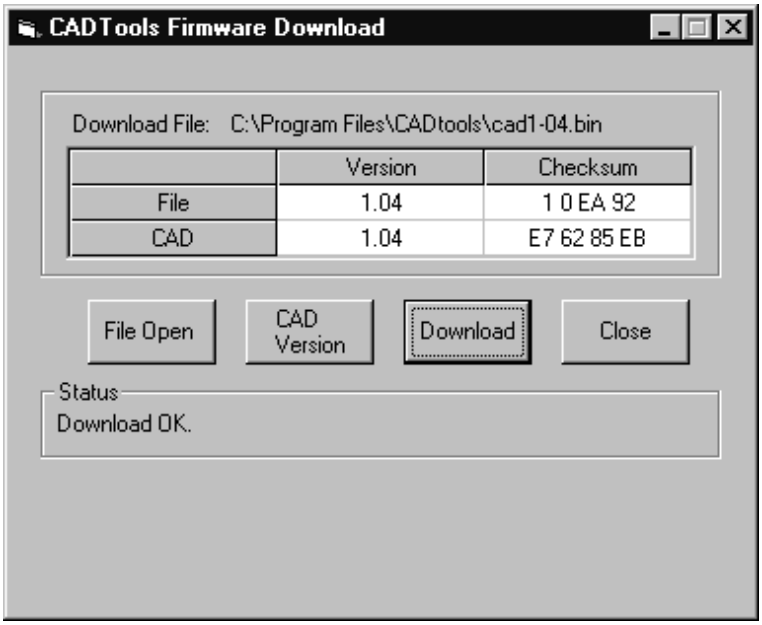
Performing FLASH Upgrade Procedure (continued)

6. The following screen will appear, displaying the progress of the download process.



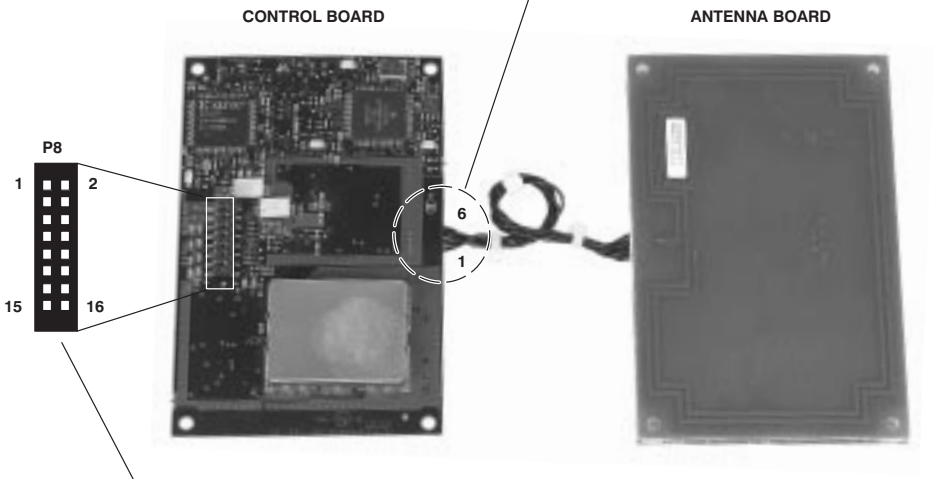
7. The following screen appears. Click on **Close**. The CAD is now running the operating software contained in the file you have just downloaded.



◆ ***End of this Procedure*** ◆

CONNECTOR P6 — CAD-to-ANTENNA BOARD

Pin #	Signal	Input	Output	Function
1	ANTENNA_RX			Future Use
2	GND	✓		Ground
3	GND			Ground
4	GND			Ground
5	ANTENNA_COIL1			Connects to other end of antenna loop
6	ANTENNA_COIL 1			Connects to other end of antenna loop

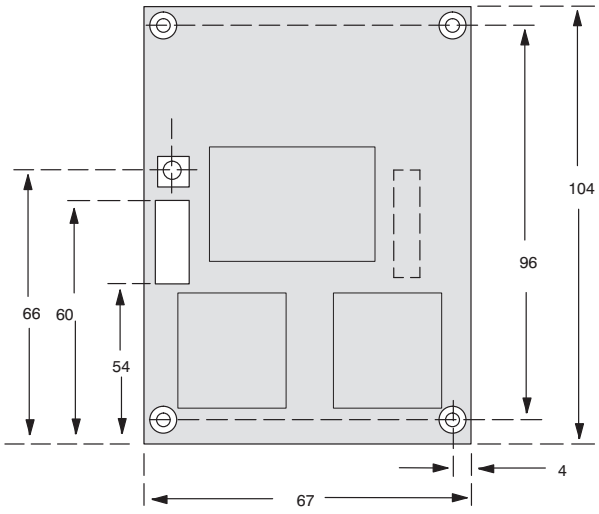


CONNECTOR P8 — 16-PIN PARALLEL TERMINAL CONNECTOR

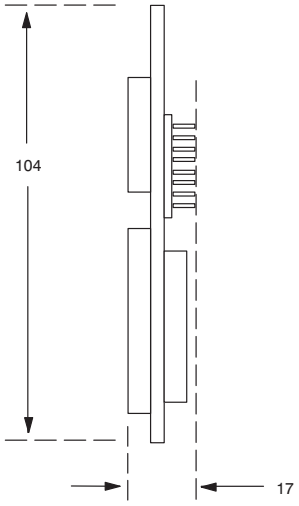
Pin #	Signal Name	Signal Level	Source	Function
1	+12V	+12 V dc	Terminal	Main DC Power
2	+12V	+12 V dc	Terminal	Main DC Power
3	GND	0 V	—	Ground
4	GND	0 V	—	Ground
5	D0	TTL	Bi-Direct	Data Bit 0 (between CAD and Terminal)
6	D1	TTL	Bi-Direct	Data Bit 1 (between CAD and Terminal)
7	D2	TTL	Bi-Direct	Data Bit 2 (between CAD and Terminal)
8	D3	TTL	Bi-Direct	Data Bit 3 (between CAD and Terminal)
9	D4	TTL	Bi-Direct	Data Bit 4 (between CAD and Terminal)
10	D5	TTL	Bi-Direct	Data Bit 5 (between CAD and Terminal)
11	D6	TTL	Bi-Direct	Data Bit 6 (between CAD and Terminal)
12	D7	TTL	Bi-Direct	Data Bit 7 (between CAD and Terminal)
13	R/W–	TTL	Terminal	Read from Terminal (high) or Write to Terminal (low)
14	STRB–	TTL	Terminal	Data Strobe (active low)
15	ACK–	TTL	CAD	Acknowledge (active low)
16	RESET–	TTL	Terminal	Hard Reset (active low)

Notes...

Control Board



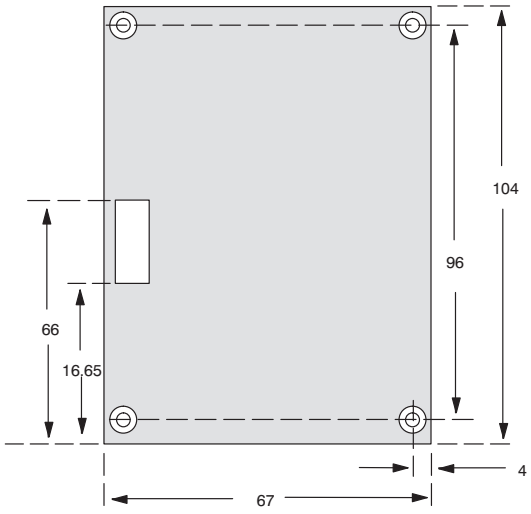
TOP VIEW



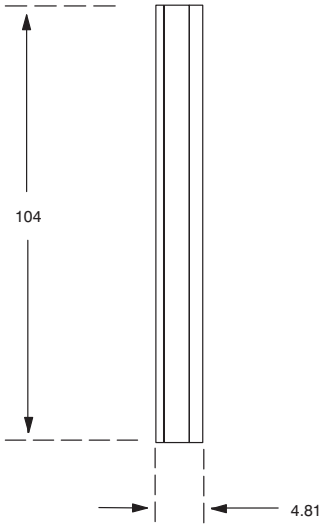
SIDE VIEW

All dimensions in millimeters

Antenna Board



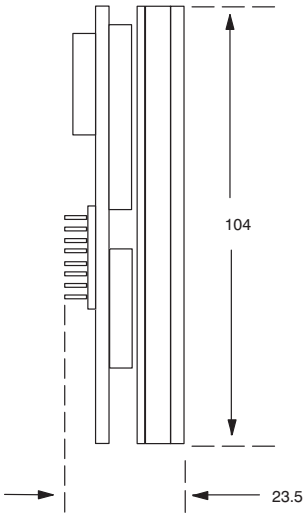
TOP VIEW



SIDE VIEW

All dimensions in millimeters

Stacked



All dimensions in millimeters

SIDE VIEW

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