

Certification Exhibit

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**FCC Rule Part: 15.209
IC Radio Standards Specification: RSS-210**

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**Manufacturer: Gilbarco, Inc.
Model: LFSQR**

Manual



The Advantage® Series, MPD® -3, Encore®, and
Eclipse® Units

TRIND® Start-up, Service, and Parts Manual

Computer Programs and Documentation

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Federal Communications Commission (FCC) Warning

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These 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 radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

Industry Canada Warning

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- this device may not cause interference, and
- this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- l'appareil ne doit pas produire de brouillage, et
- l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Approvals

Gilbarco is an ISO 9001:2008 registered company.

Underwriters Laboratories (UL):

U L File#	Products listed with U L
MH1941	All Gilbarco pumps and dispensers that bear the UL listing mark.
MH8467	Transac System 1000 and PAM 1000
E105106	Dell DHM Minitower
E165027	G-SITE and Passport Systems

California Air Resources Board (CARB):

Executive Order #	Product
G-70-52-AM	Balance Vapor Recovery
G-70-150-AE	VaporVac

National Conference of Weights and Measures (NCWM) - Certificate of Conformance (CoC):

Gilbarco pumps and dispensers are evaluated by NCWM under the National Type Evaluation Program (NTEP). NCWM has issued the following CoC:

CoC#	Product	Model #	CoC#	Product	Model #
02-019	Encore	Nxx	02-036	Legacy	Jxxx
02-020	Eclipse	Exx	02-037	G-SITE Printer (Epson)	PA0307
02-025	Meter - C Series	PA024NC10		G-SITE Distribution Box	PA0306
	Meter - C Series	PA024TC10		G-SITE Keyboard	PA0304
02-029	CRIND	—		G-SITE Mini Tower	PA0301
	TS-1000 Console	—		G-SITE Monitor	PA0303
	TS-1000 Controller	PA0241		G-SITE Printer (Citizen)	PA0308
02-030	Distribution Box	PA0242	02-038	C+ Meter	T19976
	Meter - EC Series	PA024EC10	02-039	Passport	PA0324
	VaporVac Kits	CV	02-040	Ecometer	T20453
			05-001	Titan	KXXY Series

Trademarks

Non-registered trademarks

Applause™ Media System	G-SITE® Lite™	SMART Meter™
CIM™	Highline™	SmartPad™
C-PAM™	Horizon™	Surge Management System™
ECR™	MultiLine™	Tank Monitor™
EMC™	Optimum™ Series	TCR™
FlexPay™	PAM™ 1000	Titan™
G-CAT™	PAM™	Ultra-Hi™
Gilbert™	SMART Connect™	ValueLine™
G-SITE® Link™	SMART CRIND™	

Registered trademarks

CRIND®	InfoScreen®	Transac®
Dimension® Series	Legacy®	Transac® System 1000
e-CRIND®	Making Things Better®	Trimline®
Eclipse®	MPD®	TRIND®
Encore®	Passport®	VaporVac®
G-SITE®	Performer®	
Gilbarco®	The Advantage® Series	

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1 – Introduction

TRIND® Overview

The Transmitter/Receiver IN Dispenser (TRIND) system is similar to the technology successfully used by many toll ways. It uses an electronic system located in the pump or register to “talk” with a miniature radio-like device (a tag). Together, these electronic devices provide “cashless” access to gasoline, food, and merchandise by charging purchases to a credit card, check card, or other account you already have. The TRIND system operates on a dedicated tag identification code. Your credit card or check card account numbers are not typically used with the tag signal system, which protects your account from unauthorized use. And if your tag is ever lost or stolen, your liability is limited to the amount set by your financial institution.

The TRIND device is an option available as a retrofit kit or factory installed device for The Advantage® Series, MPD®-3, Eclipse®, and Encore® lines of fuel dispensers. The device is connected to the Card Reader IN Dispenser (CRIND)® device via a Gateway or serial interface board. In this application, the TRIND device is a software slave to the CRIND and the associated Point of Sale (POS) Controller/Host. This means that a properly working TRIND system will look for and read tags, but only when “told” to by the controller, through the CRIND application.

About TRIND

The TRIND devices are developed to utilize Texas Instruments Radio Frequency Identification (RFID) technology. These devices provide two-way communications between an interrogator system in the fuel dispenser and the consumer’s hand-held or car mounted transponder tag. This two-way communication authorizes and records sales, eliminating the need for the consumer to engage in a cash or credit card transaction.

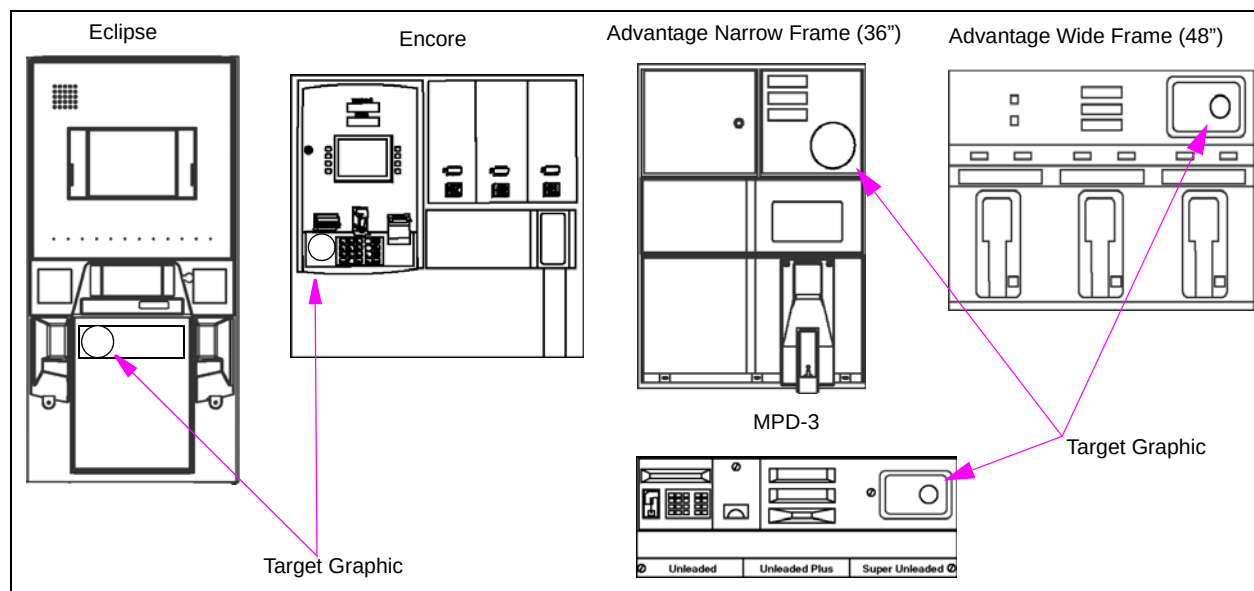
How TRIND Works

TRIND utilizes Radio Frequency (RF) waves to communicate with a customer's transponder. Transmitters located on overhead assemblies transmit radio waves that serve as a "wake up" call. As a car mounted transponder or hand-held transponder enters the transmitter's effective read zone, the transponder is activated. The transponder then transmits a code which is received by the TRIND antennas mounted overhead or on the option doors.

This transmitted code is communicated from the TRIND to the CRIND unit, and from there to the POS. The POS system communicates with a host to obtain authorization.

Car mounted transponders are activated when they are within six feet of the front of the dispenser perpendicular to front of dispenser. Hand-held transponders, usually on a key chain, function when pointed at a target graphic on the option door. Two-way communication is indicated when the option door target graphic light comes on, whether by car mount or hand-held transponder signal.

Figure 1-1: Encore and Eclipse Target Graphic Location



Related Documents

Document Number	Title	GOLD Library
MDE-2530	Pump and Dispenser Installation Manual	Advantage & Legacy® Models
MDE-2531	Start-up and Service Manual for The Advantage Series	Service Manual
MDE-2540	The Advantage, Legacy & MPD Series Owners Manual	Advantage & Legacy Models
MDE-2562	CRIND Service Manual	CRIND and TRIND
MDE-3425	CRIND Retrofit Kit and CRIND Kit Selection Guide	CRIND and TRIND
MDE-3591	TRIND Retrofits Kits C00011-002-XXXX	CRIND and TRIND
MDE-3801	TRIND Multi 1 Retrofits Kits Manual	CRIND and TRIND
MDE-3883	TRIND TIRIS C00011-005 Kit Installation Manual	CRIND and TRIND
MDE-3917	TRIND TIRIS Encore 500 Retrofit Kit Installation Manual	CRIND and TRIND
MDE-3920	Encore 300 & 500 TRIND Retrofit Kit Installation	CRIND and TRIND
MDE-4063	TRIND TIRIS Advantage and MPD-3 Retrofit Kit Installation Manual	CRIND and TRIND
MDE-4073	TRIND TIRIS C00011-006 Retrofit Kit Installation	CRIND and TRIND
PT-1728	The Advantage Illustrated Parts Manual	Parts Manual
PT-1736	The Advantage/MPD/CRIND Illustration Parts Manual	Parts Manual

Abbreviations and Acronyms

Term	Description
AIM	Association for Automatic Identification and Mobility
ASC	Authorized Service Contractor
ASK	Amplitude Shift Keying
CIM™	Customer Interface Module
CPU	Central Processing Unit
CRIND	Card Reader IN Dispenser
DCB	Data Control Board
DC	Direct Current
DIP	Dual Inline Package
EAN	European Article Numbering
EAS	Electronic Article Surveillance
EEPROM	Electrically Erasable Programmable Read-only Memory
EIRP	Effective Isotropic Radiated Power
EMI	Electromagnetic Interference
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FSK	Frequency Shift Keying
GSM	Gilbarco® Security Module
HF	High Frequency
I/O	Input Output

Term	Description
ISM	Industrial, Scientific, and Medical
LED	Light Emitting Diode
LF	Low Frequency
MOC	Major Oil Company
MOSFET	Metal-oxide-semiconductor Field-effect Transistor
MPD	Multi Product Dispensers
PCA	Printed Circuit Assembly
PCB	Printed Circuit Board
POS	Point of Sale
PSK	Phase Shift Keying
RAM	Random Access Memory
RFDC	Radio Frequency Data Communication
RFID	Radio Frequency Identification
RFM	Radio Frequency Model
RF	Radio Frequency
ROM	Read-only Memory
SMA	Sub Miniature A
TIRIS	Texas Instruments Registration and Identification Systems
TRIND	Transmitter/Receiver IN Dispenser
TTL	Transistor-Transistor Logic
UCC	Uniform Code Council
UHF	Ultra High Frequency
UL®	Underwriters' Laboratories
VDC	Voltage Direct Current
WORM	Write Once Read Many

TRIND Kit Coverage

Following table provides TRIND kit numbers and the relative system coverage that applies to each:

Kit Number	Product Coverage	Frequencies	Interface Type	Tag System
C00011-001	The Advantage Series, MPD-3	LF/UHF	T20229-G1 Card Cage	Hand-held/Car Mounted
C00011-002	The Advantage Series, MPD-3	LF/UHF (see note 2)	T20606-G2 Card Cage	Hand-held/Car Mounted
C00011-005	The Advantage Series, MPD-3	LF (see note1)	T20606-G3 Card Cage	Hand-held
C00011-004	Encore 500	LF/UHF	T20606-G2 Card Cage	Hand-held/Car Mounted
C00011-006	Encore 500, Eclipse	LF	T20606-G3 Card Cage	Hand-held
C00011-007	The Advantage Series, MPD-3	LF/UHF [ETSI (see note 3)]	T20606-G5 Card Cage	Hand-held/Car Mounted
C00011-008	Encore 500	LF/UHF (ETSI)	T20606-G2 Card Cage	Hand-held/Car Mounted
C00011-009	The Advantage Series, MPD-3	LF/UHF	T20606-G5 Card Cage	Hand-held/Car Mounted
C00011-010	The Advantage Series, MPD-3	LF/UHF	T20606-G2 Card Cage	Hand-held/Car Mounted
C00012-00X	The Advantage Series, MPD-3	HF (see note 4)	T20538-G1/G2 Card Cage	Hand-held

Notes:

1. LF = Low Frequency [LF (134 kHz)] send and receive for Hand-held Tags.
2. LF/UHF = LF (134kHz) send, and Ultra-Hi Frequency [UHF (902 MHz)] receive for Car Tags. LF (134 kHz) for Hand-held Tags.
3. LF/UHF (ETSI) = LF (134 kHz) send and UHF (868 MHz) receive for Car Tags. LF (134 kHz) for Hand-held Tags.
4. HF = High Frequency [HF (13.56 MHz)] send and receive for Hand-held Tags.

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2 – Important Safety Information

Notes: 1) *Save this Important Safety Information section in a readily accessible location.*

2) *Although DEF is non-flammable, Diesel is flammable. Therefore, for DEF cabinets that are attached to Diesel dispensers, follow all the notes in this section that pertain to flammable fuels.*

This section introduces the hazards and safety precautions associated with installing, inspecting, maintaining or servicing this product. Before performing any task on this product, read this safety information and the applicable sections in this manual, where additional hazards and safety precautions for your task will be found. Fire, explosion, electrical shock or pressure release could occur and cause death or serious injury, if these safe service procedures are not followed.

Preliminary Precautions

You are working in a potentially dangerous environment of flammable fuels, vapors, and high voltage or pressures. Only trained or authorized individuals knowledgeable in the related procedures should install, inspect, maintain or service this equipment.

Emergency Total Electrical Shut-Off

The first and most important information you must know is how to stop all fuel flow to the pump/dispenser and island. Locate the switch or circuit breakers that shut off all power to all fueling equipment, dispensing devices, and Submerged Turbine Pumps (STPs).

 WARNING	
	The EMERGENCY STOP, ALL STOP, and PUMP STOP buttons at the cashier's station WILL NOT shut off electrical power to the pump/dispenser. This means that even if you activate these stops, fuel may continue to flow uncontrolled.
	
You must use the TOTAL ELECTRICAL SHUT-OFF in the case of an emergency and not the console's ALL STOP and PUMP STOP or similar keys.	

Total Electrical Shut-Off Before Access

Any procedure that requires access to electrical components or the electronics of the dispenser requires total electrical shut off of that unit. Understand the function and location of this switch or circuit breaker before inspecting, installing, maintaining, or servicing Gilbarco equipment.

Evacuating, Barricading and Shutting Off

Any procedure that requires access to the pump/dispenser or STPs requires the following actions:



- An evacuation of all unauthorized persons and vehicles from the work area
- Use of safety tape, cones or barricades at the affected unit(s)
- A total electrical shut-off of the affected unit(s)

Read the Manual

Read, understand and follow this manual and any other labels or related materials supplied with this equipment. If you do not understand a procedure, call a Gilbarco Authorized Service Contractor or call the Gilbarco Support Center at 1-800-800-7498. It is imperative to your safety and the safety of others to understand the procedures before beginning work.

Follow the Regulations

Applicable information is available in National Fire Protection Association (NFPA) 30A; *Code for Motor Fuel Dispensing Facilities and Repair Garages*, NFPA 70; *National Electrical Code (NEC)*, Occupational Safety and Health Administration (OSHA) regulations and federal, state, and local codes. All these regulations must be followed. Failure to install, inspect, maintain or service this equipment in accordance with these codes, regulations and standards may lead to legal citations with penalties or affect the safe use and operation of the equipment.

Replacement Parts

Use only genuine Gilbarco replacement parts and retrofit kits on your pump/dispenser. Using parts other than genuine Gilbarco replacement parts could create a safety hazard and violate local regulations.

Safety Symbols and Warning Words

This section provides important information about warning symbols and boxes.

Alert Symbol



This safety alert symbol is used in this manual and on warning labels to alert you to a precaution which must be followed to prevent potential personal safety hazards. Obey safety directives that follow this symbol to avoid possible injury or death.

Signal Words

These signal words used in this manual and on warning labels tell you the seriousness of particular safety hazards. The precautions below must be followed to prevent death, injury or damage to the equipment:



DANGER: Alerts you to a hazard or unsafe practice which will result in death or serious injury.



WARNING: Alerts you to a hazard or unsafe practice that could result in death or serious injury.



CAUTION with Alert symbol: Designates a hazard or unsafe practice which may result in minor injury.

CAUTION without Alert symbol: Designates a hazard or unsafe practice which may result in property or equipment damage.

Working With Fuels and Electrical Energy

Prevent Explosions and Fires

Fuels and their vapors will explode or burn, if ignited. Spilled or leaking fuels cause vapors. Even filling customer tanks will cause potentially dangerous vapors in the vicinity of the dispenser or island.

DEF is non-flammable. Therefore, explosion and fire safety warnings do not apply to DEF fluid lines.

Important Safety Information

No Open Fire



Open flames from matches, lighters, welding torches or other sources can ignite fuels and their vapors.

No Sparks - No Smoking



Sparks from starting vehicles, starting or using power tools, burning cigarettes, cigars or pipes can also ignite fuels and their vapors. Static electricity, including an electrostatic charge on your body, can cause a spark sufficient to ignite fuel vapors. Every time you get out of a vehicle, touch the metal of your vehicle, to discharge any electrostatic charge before you approach the dispenser island.

Working Alone

It is highly recommended that someone who is capable of rendering first aid be present during servicing. Familiarize yourself with Cardiopulmonary Resuscitation (CPR) methods, if you work with or around high voltages. This information is available from the American Red Cross. Always advise the station personnel about where you will be working, and caution them not to activate power while you are working on the equipment. Use the OSHA Lockout/Tagout procedures. If you are not familiar with this requirement, refer to this information in the service manual and OSHA documentation.

Working With Electricity Safely

Ensure that you use safe and established practices in working with electrical devices. Poorly wired devices may cause a fire, explosion or electrical shock. Ensure that grounding connections are properly made. Take care that sealing devices and compounds are in place. Ensure that you do not pinch wires when replacing covers. Follow OSHA Lockout/Tagout requirements. Station employees and service contractors need to understand and comply with this program completely to ensure safety while the equipment is down.

Hazardous Materials

Some materials present inside electronic enclosures may present a health hazard if not handled correctly. Ensure that you clean hands after handling equipment. Do not place any equipment in the mouth.

WARNING

The pump/dispenser contains a chemical known to the State of California to cause cancer.

WARNING

The pump/dispenser contains a chemical known to the State of California to cause birth defects or other reproductive harm.

In an Emergency

Inform Emergency Personnel

Compile the following information and inform emergency personnel:

- Location of accident (for example, address, front/back of building, and so on)
- Nature of accident (for example, possible heart attack, run over by car, burns, and so on)
- Age of victim (for example, baby, teenager, middle-age, elderly)
- Whether or not victim has received first aid (for example, stopped bleeding by pressure, and so on)
- Whether or not a victim has vomited (for example, if swallowed or inhaled something, and so on)

WARNING



Gasoline/DEF ingested may cause unconsciousness and burns to internal organs. Do not induce vomiting. Keep airway open. Oxygen may be needed at scene. Seek medical advice immediately.

WARNING

DEF generates ammonia gas at higher temperatures. When opening enclosed panels, allow the unit to air out to avoid breathing vapors. If respiratory difficulties develop, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention.

WARNING



Gasoline inhaled may cause unconsciousness and burns to lips, mouth and lungs. Keep airway open. Seek medical advice immediately.

WARNING



Gasoline/DEF spilled in eyes may cause burns to eye tissue. Irrigate eyes with water for approximately 15 minutes. Seek medical advice immediately.

WARNING



Gasoline/DEF spilled on skin may cause burns. Wash area thoroughly with clear water. Seek medical advice immediately.

WARNING

DEF is mildly corrosive. Avoid contact with eyes, skin, and clothing. Ensure that eyewash stations and safety showers are close to the work location. Seek medical advice/recommended treatment if DEF spills into eyes.

IMPORTANT: Oxygen may be needed at scene if gasoline has been ingested or inhaled. Seek medical advice immediately.

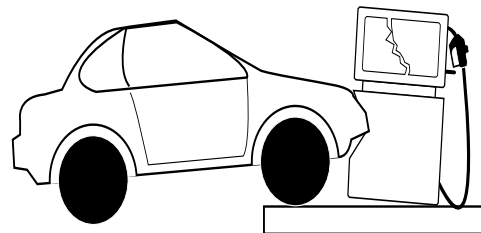
Lockout/Tagout

Lockout/Tagout covers servicing and maintenance of machines and equipment in which the unexpected energization or start-up of the machine(s) or equipment or release of stored energy could cause injury to employees or personnel. Lockout/Tagout applies to all mechanical, hydraulic, chemical, or other energy, but does not cover electrical hazards. Subpart S of 29 CFR Part 1910 - Electrical Hazards, 29 CFR Part 1910.333 contains specific Lockout/Tagout provision for electrical hazards.

Hazards and Actions

 WARNING	
	Spilled fuels, accidents involving pumps/dispensers, or uncontrolled fuel flow create a serious hazard.
	Fire or explosion may result, causing serious injury or death.
	Follow established emergency procedures.
	DEF is non-flammable. However it can create a slip hazard. Clean up spills promptly.

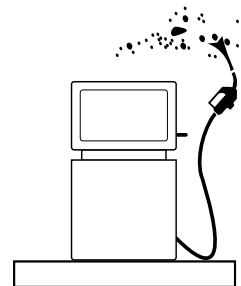
The following actions are recommended regarding these hazards:



Collision of a Vehicle with Unit



Fire at Island



Fuel Spill

- Do not go near a fuel spill or allow anyone else in the area.
- Use station EMERGENCY CUTOFF immediately. Turn off all system circuit breakers to the island(s).
- Do not use console E-STOP, ALL STOP, and PUMP STOP to shut off power. These keys do not remove AC power and do not always stop product flow.
- Take precautions to avoid igniting fuel. Do not allow starting of vehicles in the area. Do not allow open flames, smoking or power tools in the area.
- Do not expose yourself to hazardous conditions such as fire, spilled fuel or exposed wiring.
- Call emergency numbers.

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3 – Systems Overview

Full Systems

The Full System product is an option available as a retrofit kit or factory installed equipment on The Advantage Series, Multi Product Dispenser (MPD-3), Encore, and Eclipse lines of fuel dispensers. The TRIND device is connected to the CRIND through a gateway or serial interface board. In this application TRIND is a software slave to the CRIND and the associated POS controller/host. This means that a properly working TRIND system will look for and read tags, but only when told to by the controller, through the CRIND application.

This system is to be installed in accordance with all Underwriters' Laboratory (UL), Federal Communications Commission (FCC), federal, state, and local regulations associated with it. The following illustrations depict the system component used in the Original, The Advantage Series, MPD-3, and Encore Full Systems.

Figure 3-1: Original Full System Block Diagram

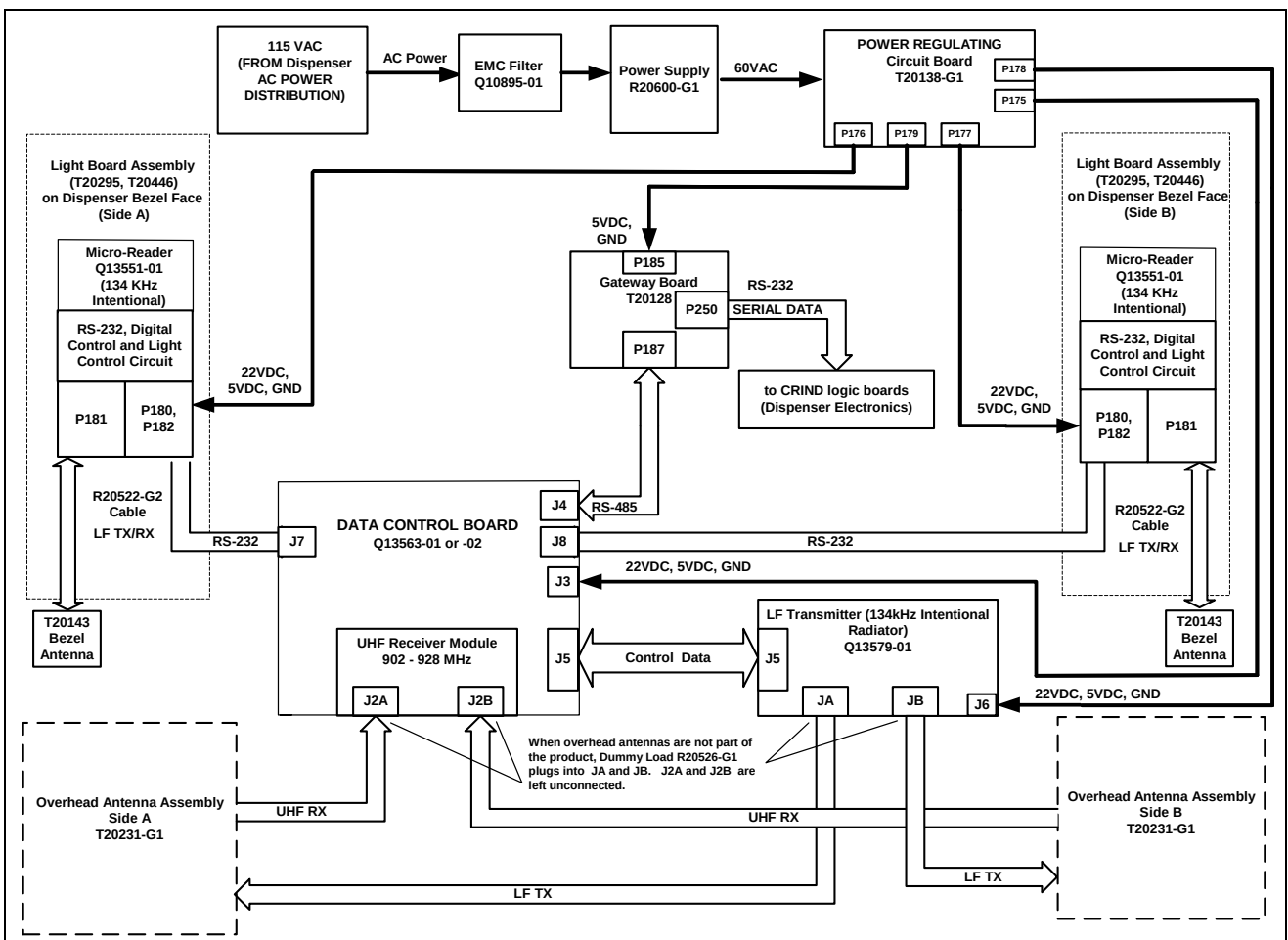


Figure 3-2: The Advantage Series Full System Block Diagram

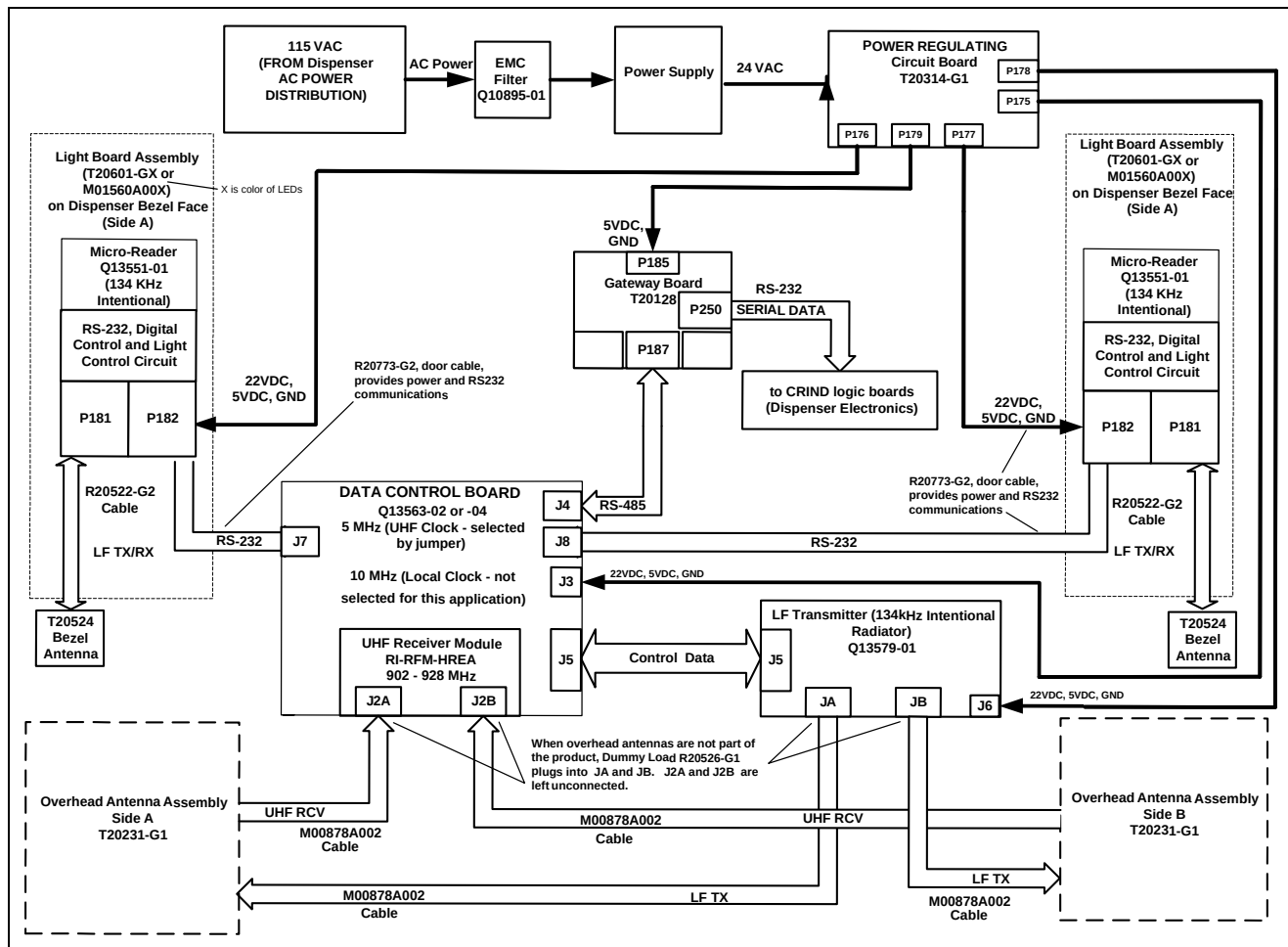
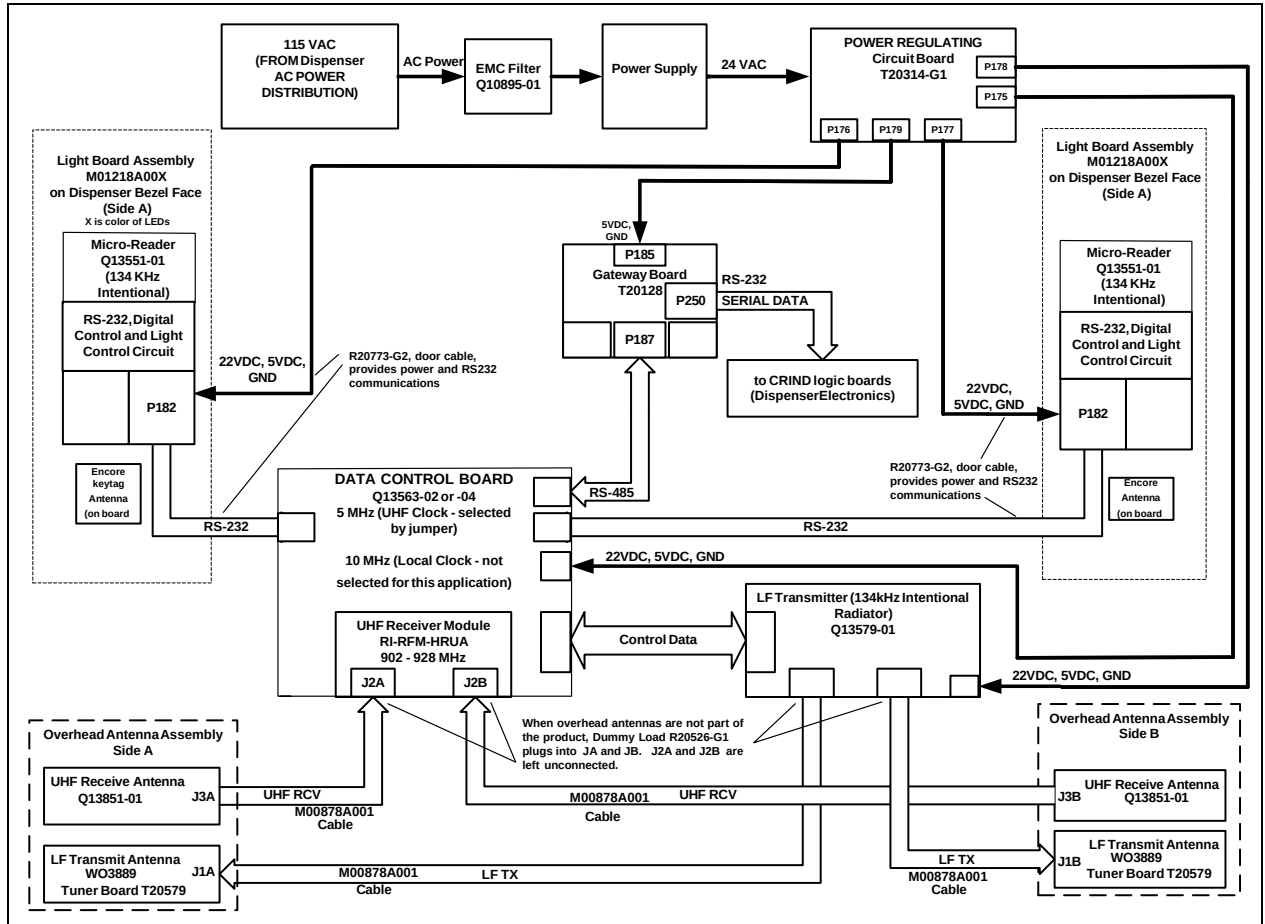
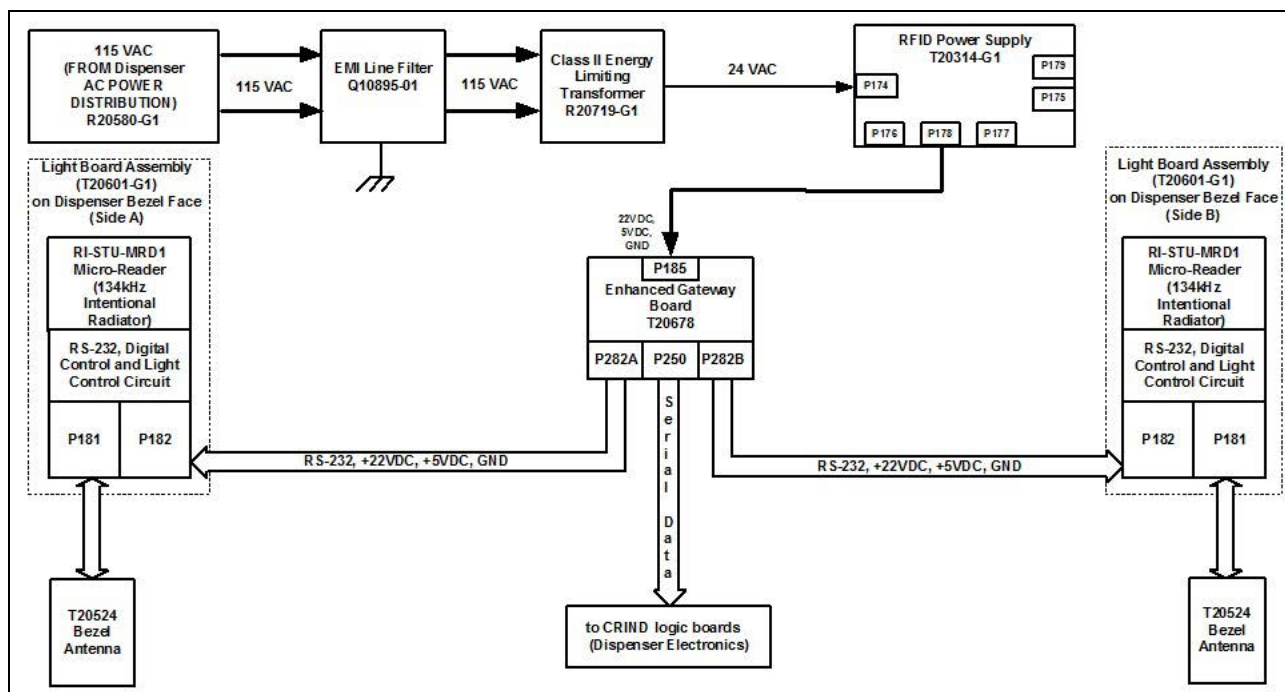


Figure 3-3: Encore Full System Block Diagram



This product is an option available as a retrofit kit or factory installed equipment in The Advantage Series, MPD-3, and Encore lines of fuel dispensers. The TRIND Enhanced Gateway Board (T20678) manages RFID processing and provides simple, generic event messages to the pump electronics via Transistor-Transistor Logic (TTL). In this application, TRIND is a software slave to the CRIND and the associated POS controller/host. This means that a properly working LF TRIND system will look for and read tags, but only when told to by the controller, through the CRIND application.

Figure 3-4: Hand-held Only Tag System Block Diagram



4 – Major Hardware Components

Card Cage Assemblies

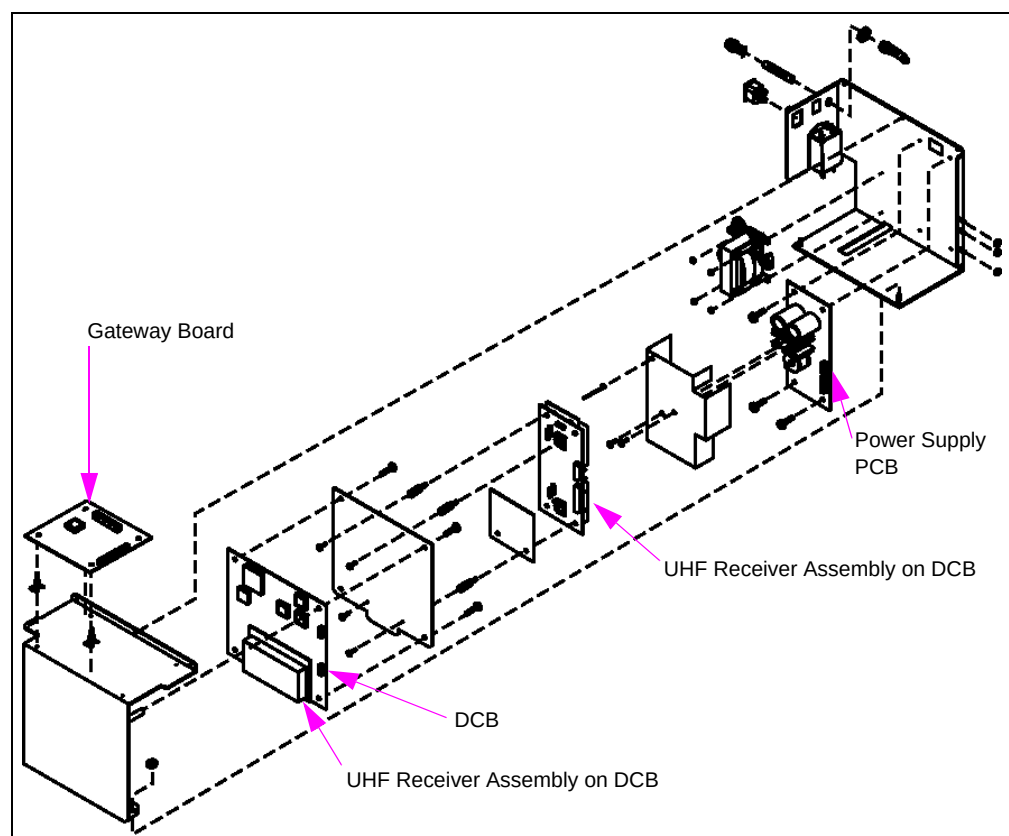
There are four main Card Cage versions used for the TRIND system. These four Card Cages are T20229-G1, T20606-G2, T20606-G3, and T20606-G5. The T20229 Card Cage is no longer available and is discussed in this manual simply for the service and support of the installed base. There are other G-levels of the T20606 Card Cage, but these are variations of the -G2 and -G3. Therefore, being familiar with these base Card Cages and their parts will provide the technician with valuable information in servicing the other G-levels, if encountered.

Note: Many parts look similar in the T20229 and T20606 Card Cages, but they are not the same. Always replace the removed part with the same part number or risk voiding the UL listings, FCC certifications, warranty, if applicable.

T20229-G1 Card Cage Assembly

The T20229 Card Cage was the installed Card Cage for the original Mobil Speedpass program. With a few cable changes, this Card Cage can be replaced by the T20606-G2 Card Cage, which contains the new Multi-port Data Control Board (DCB) from Texas Instruments.

Figure 4-1: T20229-G1 Card Cage Assembly



T20229-G1 Card Cage Assembly Parts List

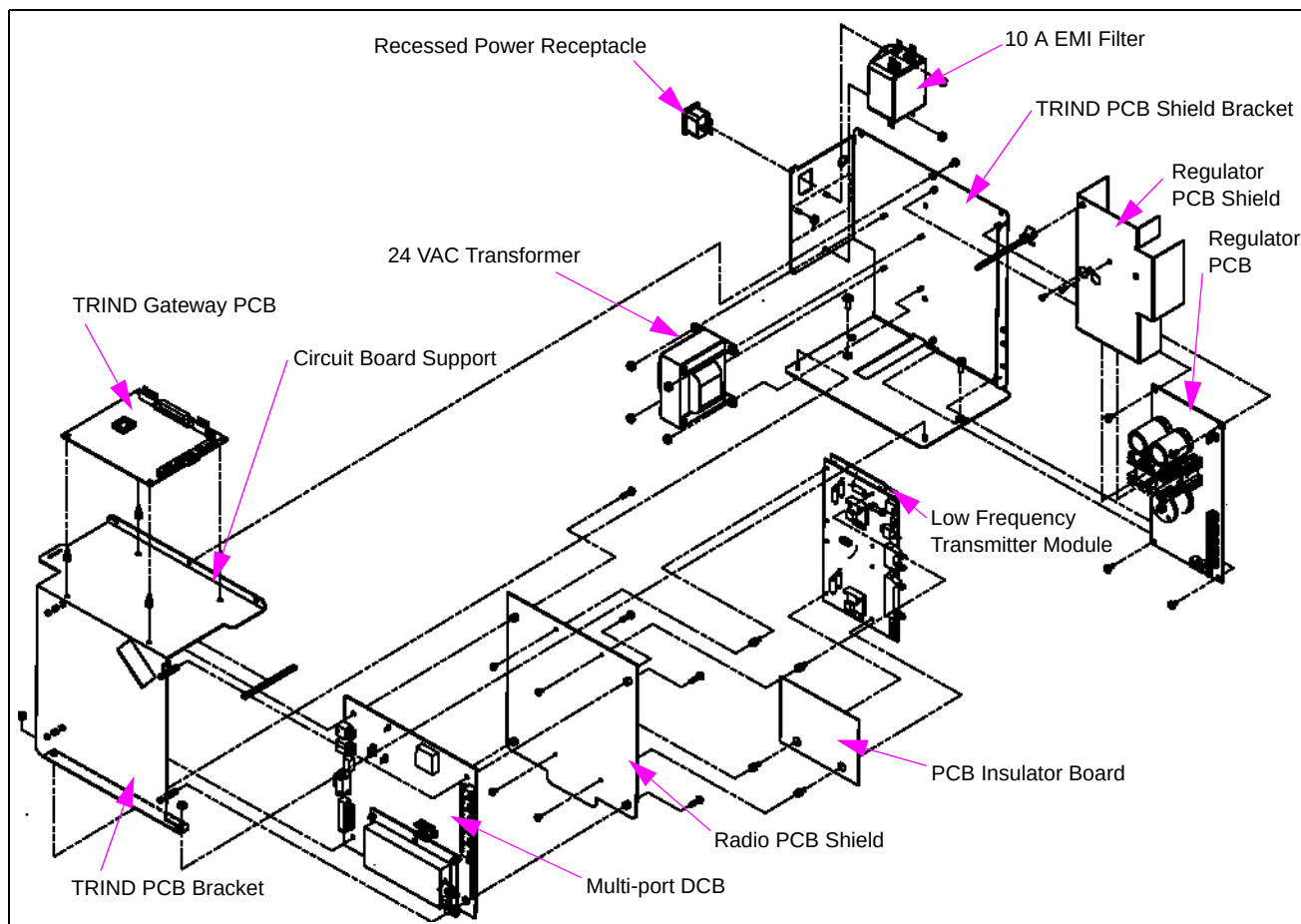
Following table lists the T20229-G1 Card Cage Assembly parts:

Item	Description	Part Number
1	Power Supply PCB	T20138-G1
2	Transmitter PCB Assembly	Q13579-01
3	DCB	Q13563-01
4	UHF Receiver Assembly on DCB	Q13564-01
5	Gateway Board	T20128-G1

T20606-G2 Card Cage Assembly

T20606-G2 Card Cage is the updated version of the T20229-G1 Card Cage. It features a multi-port DCB, LF Transmitter, and a high-gain UHF receiver. It also has a Card Cage Harness, which reduces the number of field connections that must be made (compared to T20229). This Card Cage comes ready to mount in an Encore unit, and also easily modified to work in Eclipse, The Advantage Series, and MPD-3 units.

Figure 4-2: T20606-G2 Card Cage Assembly



T20606-G2 Card Cage Assembly Parts List

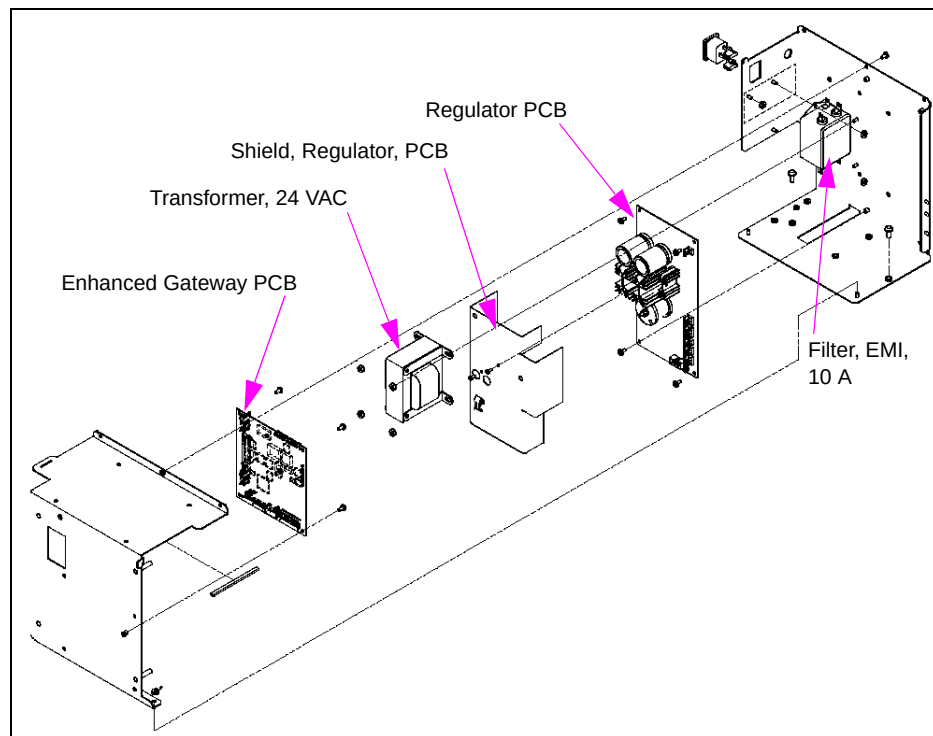
Following table lists the T20606-G2 Card Cage Assembly parts:

Item	Description	Part Number
1	TRIND Gateway PCB	T20128-G3
2	Circuit Board Support	Q10651-16
3	TRIND PCB Bracket	M00624A001
4	Multi-port DCB	Q13563-04
5	Radio PCB Shield	R20545-G1
6	PCB Insulator Board	R20590-01
7	Low Frequency Transmitter Module	Q13579-01
8	24 VAC Transformer	R20719-G1
9	Recessed Power Receptacle	R20206-G14
10	10 A EMI Filter	Q10895-01
11	TRIND PCB Shield Bracket	M00621A001
12	Regulator PCB Shield	T20198-01
13	Regulator PCB	T20314-G1

T20606-G3 Card Cage Assembly

T20606-G3 Card Cage supports “keytag only” operation and features an Enhanced Gateway Board, which serves as the local controller for the RF modules (taking the place of the DCB) and the protocol handler for payment messaging (to CRIND or other Host Controller device). This Card Cage comes ready to mount in Encore, The Advantage Series, Eclipse and MPD-3, with no modifications required.

Figure 4-3: T20606-G3 Card Cage Assembly



T20606-G3 Card Cage Assembly Parts List

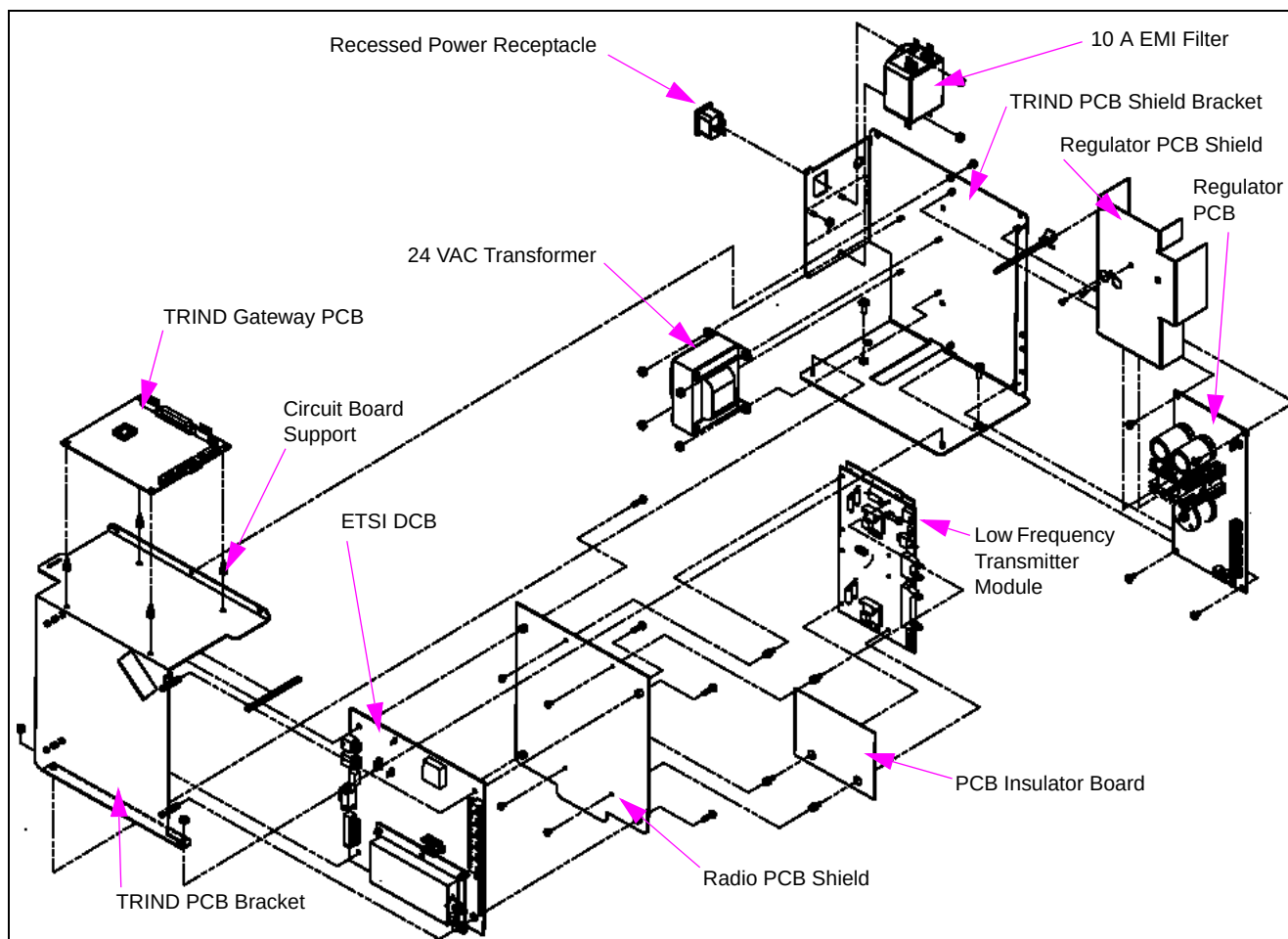
Following table lists the T20606-G3 Card Cage Assembly parts:

Item	Description	Part Number
1	Regulator PCB	T20314-G1
2	Regulator PCB Shield	T20198-01
3	24 VAC Transformer	R20719-G1
4	Enhanced Gateway PCB	T20678-G1
5	10 A EMI Filter	Q10895-01

T20606-G5 Card Cage Assembly

T20606-G5 Card Cage is a variation of the T20606-G2 Card Cage required for many international “full system” TRIND applications (Europe and southeast Asia). It features a European Telecommunications Standards Institute (ETSI) DCB, LF Transmitter, and a high-gain UHF receiver. It also has a Card Cage Harness, which reduces the number of field connections that must be made (compared to the original T20229). This Card Cage comes ready to mount in an Encore unit, and is easily modified to also work in Eclipse, The Advantage Series, and MPD-3 units.

Figure 4-4: T20606-G5 Card Cage Assembly



T20606-G5 Card Cage Assembly Parts List

Following table lists the T20606-G5 Card Cage Assembly parts:

Item	Description	Part Number
1	TRIND Gateway PCB	T20128-G3
2	Circuit Board Support	Q10651-16
3	TRIND PCB Bracket	M00624A001
4	ETSI DCB	Q13563-07
5	Radio PCB Shield	R20545-G1
6	PCB Insulator Board	R20590-01
7	Low Frequency Transmitter Module	Q13579-01
8	24 VAC Transformer	R20719-G1
9	Recessed Power Receptacle	R20206-G14
10	10 A EMI Filter	Q10895-01
11	TRIND PCB Shield Bracket	M00621A001
12	Regulator PCB Shield	T20198-01
13	Regulator PCB	T20314-G1

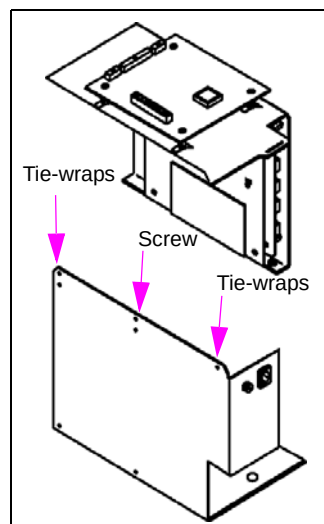
Disassembly and Installation for MPD-3 Units with SID Displays

In some older installations, a screw and two nuts were installed under the Card Cage on Side B of a unit. This causes the installed Card Cage to rest at an angle, higher on Side B. This hardware must remain in place to prevent contact between the Card Cage and the SID boards when the bezel door is closed.

Disassembly and Installation for All MPD-3 Units

In field retrofits, the TRIND units top (center) screw from the Card Cage was removed, and replaced by tie-wraps at either side after the Card Cage was installed in the cabinet. The Card Cage can only be removed or installed when separated into two pieces (see [Figure 4-5](#)).

Figure 4-5: Screw and Tie-wrap Locations



AC EMI Line Filter (Q10895)

AC Electromagnetic Interference (EMI) Line Filter, is a Corcom dual T section RFI power line filter. These filters are well suited for low impedance loads where noisy RFI environments are present. They control pulsed, continuous and/or intermittent interference, insuring protection of the TRIND equipment from power line noise in addition to protecting the line from equipment noise.

R20600 and R20719 Transformers

R20600-G1 Transformer is used in the T20229-G2 Card Cage Assembly. R20719-G1 Transformer is used in the T20606-G2 LF/UHF Full System, and Enhanced Gateway System Card Cages. Each transformer performs step down of 120 VAC to a usable level for the RFID Power Supply. The R20600 steps 120 VAC down to 60 VAC, which is used by the T20138-G1 Power Supply Board. The R20719 steps 120 VAC down to 24 VAC, which is used by the T20314-G1 Power Supply Board.

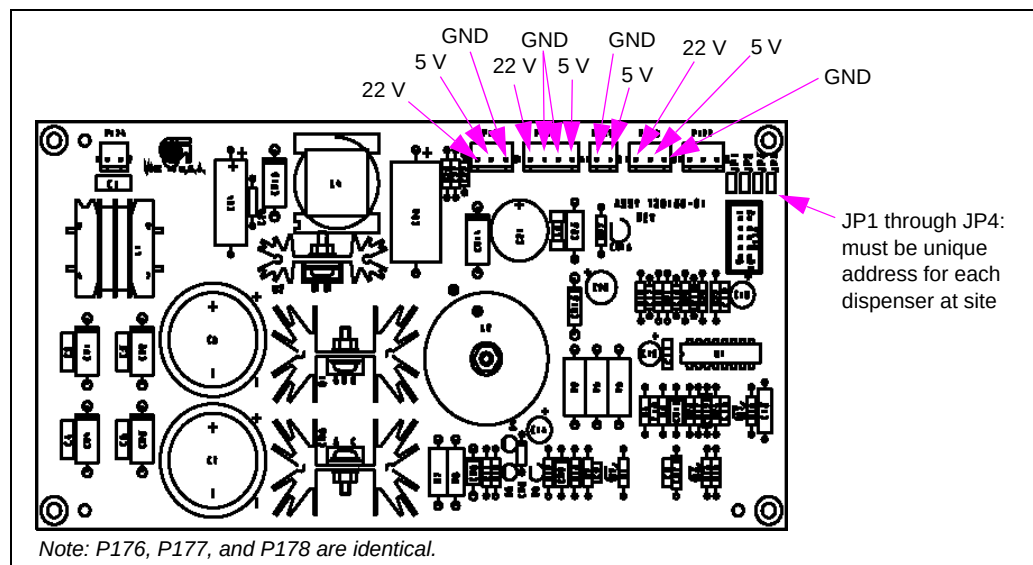
T20138 and T20314 Power Supply Boards

T20138-G1 Power Supply Board is used in the T20229-G1 Full System Card Cage Assembly. T20314-G1 Power Supply Board is used in T20606 line of Card Cages. The supplies take the output of their respective AC to AC transformers and make the proper Direct Current (DC) voltages for use by the TRIND system components. Both supplies utilize a gate-driven Metal-oxide-semiconductor Field-effect Transistor [MOSFET (for +22 VDC)] and a buck switched mode power supply (for +5 VDC). Both supplies monitor the current on the output to turn off the gate drive, rather than fail permanently, should one of the TRIND system components develop a voltage problem. This arrangement allows for any of the outputs to be shorted directly to ground with out harming the power supply because it turns itself off until the problem is discovered and removed, and AC power is cycled.

T20138 Power Supply Board

This board has jump-jack locations to set the dither sync (refer to “[Glossary](#)” on [page 4-1](#)) address for the TRIND unit, with a 10-position ribbon cable (at P173) that goes to the DCB (J6). These addresses only matter to the site itself, not the pump or CRIND.

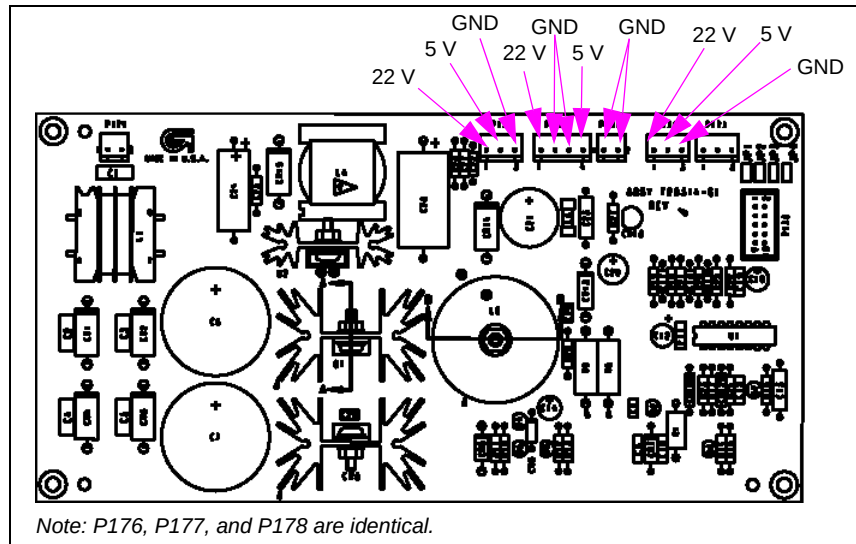
Figure 4-6: T20138 Power Supply Board



T20314 Power Supply Board

This board must be used in conjunction with the R20719 Transformer.

Figure 4-7: T20314 Power Supply Board



Q13563 Data Control Boards

Q13563-01 and Q13563-02 Data Control Boards are used in T20229-G1 Full System Card Cage assembly. The Q13563-04 Board is used in T20606-G2 Full System Card Cage assembly. These DCBs handle tag reader control and pass the system status, and tag data up to the Gateway Board. The earlier versions (-01, -02) of this board made use of jump jacks on the Power Supply Board for dither sync addressing, subsequent versions (-04 and above) contain Dual Inline Package (DIP) switches for this site-specific addressing.

Figure 4-8: Q13563-01 and Q13563-02 DCBs

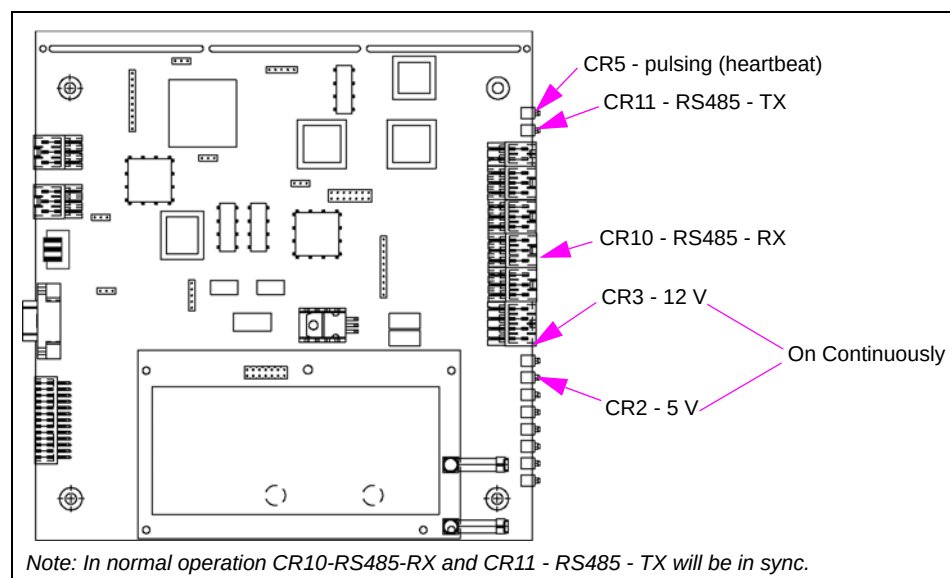
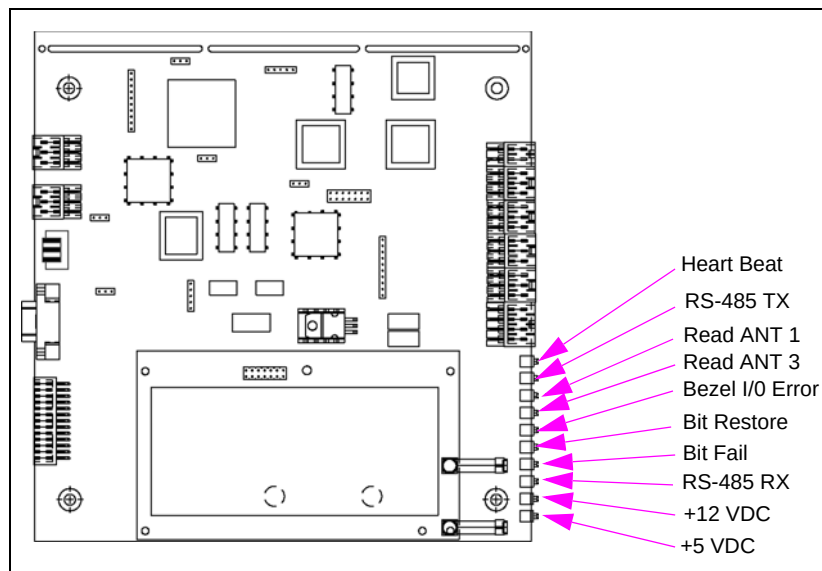
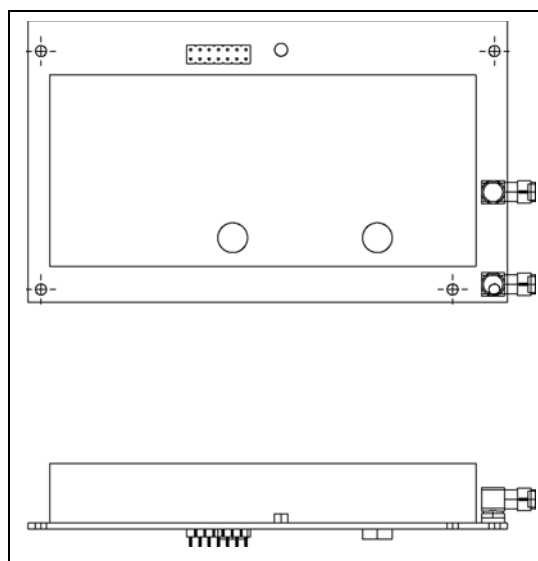


Figure 4-9: Q13563-04 DCBs and Above

UHF Receiver Board (Q13564)

Mounted on the DCB, the UHF Receiver Board receives 12 VDC from the DCB. The board also receives information from UHF antennas over J2A or J2B and processes the UHF signal. This receiver has to comply with FCC and in-country communication protocols such as ETSI. For this application the ETSI protocol is required for Asia and Europe.

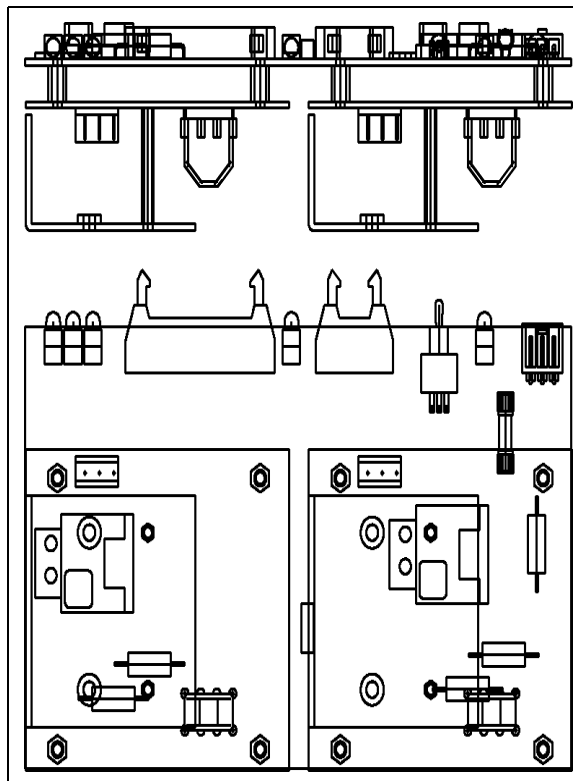
Figure 4-10: UHF Receiver Board

The UHF Receiver Module contained on the DCB, handles the uplink signal from the vehicle tag. It receives the signal from the vehicle tag that transmits data on a UHF carrier, and down converts and demodulates this signal to binary data. The UHF Receiver also includes the master oscillator for the DCB and provides all clock signals for other elements within the DCB to keep signal paths as short as possible. The UHF receive antenna connections are made via Sub Miniature A (SMA) connectors on Antenna Cables (M00878A001, M00878A002, and Q13578-01).

Q13579 Transmitter Board

Q13579-01 Transmitter Board is used in the T20229-G1 and T20606-G2 Full System Card Cages. The Transmitter Board is actually a three-board assembly containing two identical transmitter modules (one each for Sides A and B) mounted on a larger Printed Circuit Board (PCB). The Q13579-01 Transmitter Board contains all the functions to activate vehicle tags. The module includes a carrier board onto which are mounted two transmit-only Radio Frequency Modules (RFMs), the power supply, oscillator and tuning connector for the RFMs, logic circuitry to determine RFM selection, power level adjustment capability, and a pulse width modulation circuit. This board receives +22 VDC, +5 VDC and GND through J6. If this board is replaced, overhead antennas need to be retuned. The transmitter provides an approximate 134 kHz signal for TRIND antennas, through JA for Side A and JB for Side B of the dispenser.

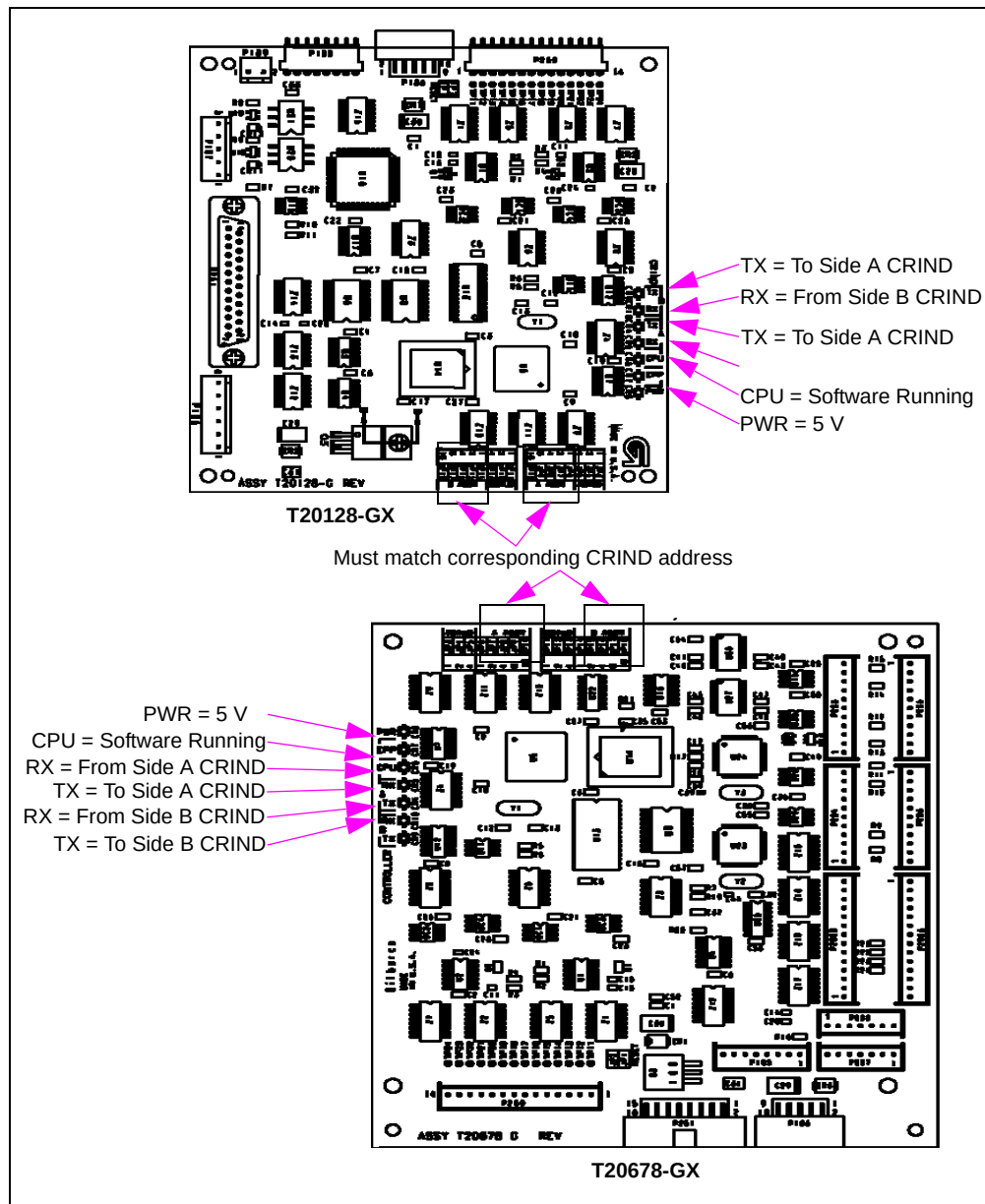
Figure 4-11: Transmitter Board



T20128 and T20678 Gateway Boards

T20128-GX Gateway Board is used in the Full System T20229-G1 and T20606-G2 Card Cages. The T20678 Gateway Board is used in the T20606-G3 Card Cage. These boards manage events and message processing to/from the Controller (CRIND, POS, host controller) and the readers. On the full systems, the Gateway Board manages RFID processing through the DCB (which communicates with the vehicle tags via overhead antennas and with hand-held tags via bezel readers). On Enhanced Gateway systems, the board manages hand-held RFID processing through direct communication with the bezel readers.

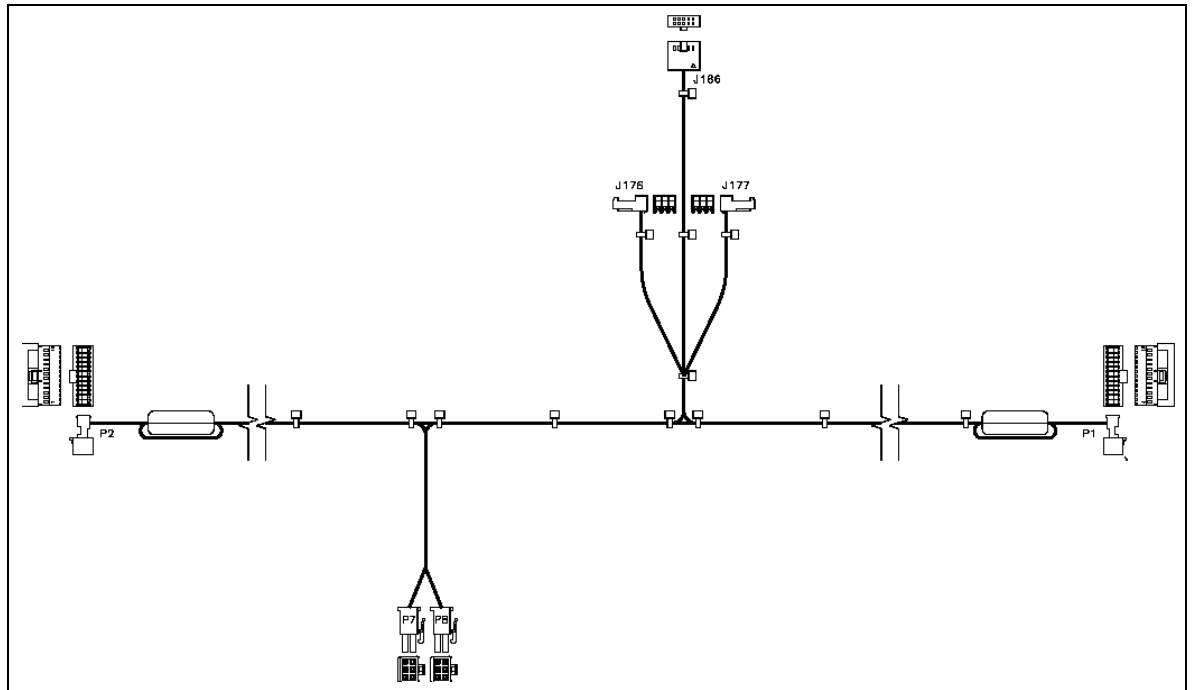
Figure 4-12: Gateway Boards



Card Cage Cable Harness (T20662-G2)

The Card Cage Cable Harness Assembly provides power and data distribution to/from the Card Cage and the Light/Micro Reader Printed Circuit Assembly (PCA). It comes already installed on the T20606-G2 Card Cage from the factory.

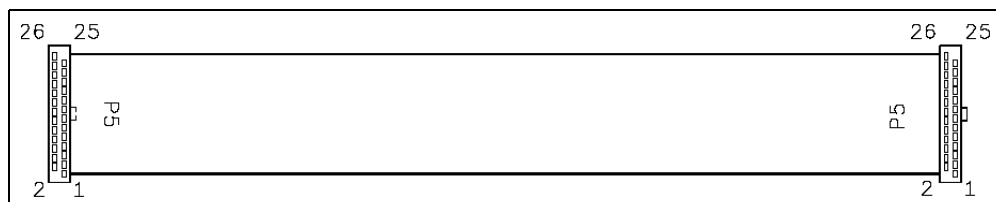
Figure 4-13: Card Cage Cable Harness



Full System TRIND Transmitter Cable (R20520-G1)

The Transmitter Cable is a 26-pin connector cable that is routed between the Low Frequency Transmitter Board (Q13579) and DCB (Q13563).

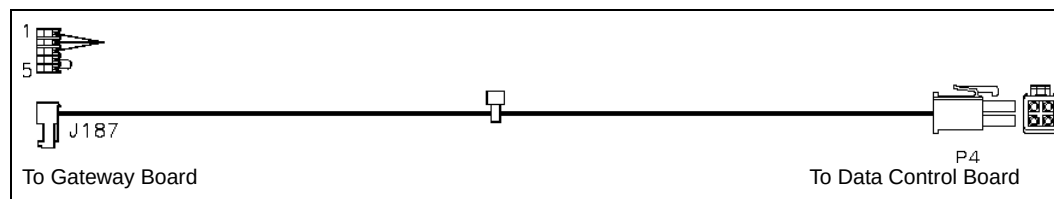
Figure 4-14: Transmitter Cable



Full System TRIND RS-485 Communication Cable (R20525-G1)

The Communication Cable is a 4-pin and 5-pin connector cable that is connected between the Q13563 DCB and T20128 Gateway Board.

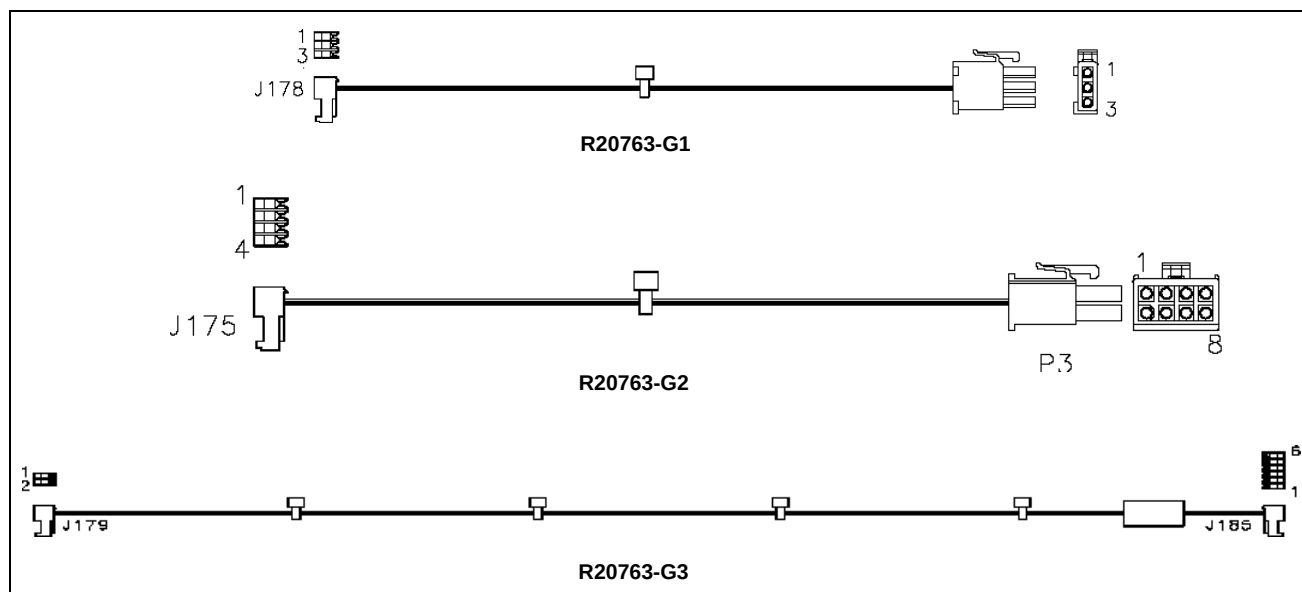
Figure 4-15: RS-485 Communication Cable



Full System TRIND Power Supply Cables (R20763-GX)

The Power Supply Cables connect the LF Transmitter (-G1), the DCB (-G2), and the Gateway (-G3) Boards to the T20314 Power Supply.

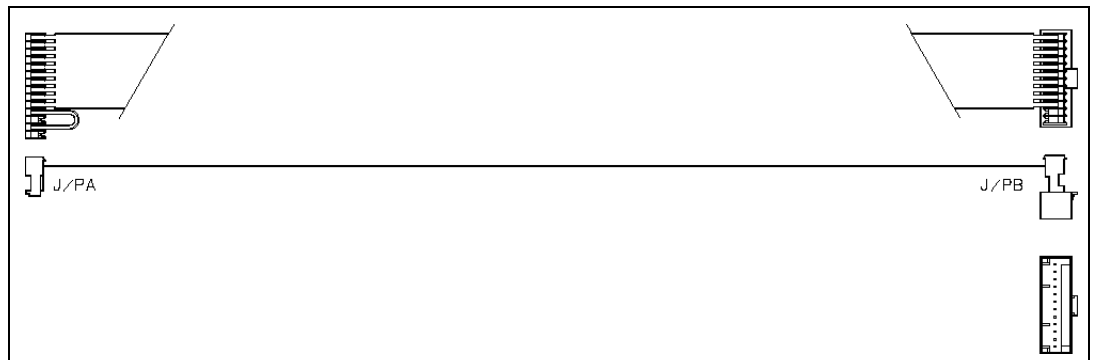
Figure 4-16: Power Supply Cables



Hand-held TRIND System Ribbon Cable (M00507)

The Ribbon Cable is a 14-pin cable routed between T12678 Gateway Board and R20773 TRIND Option Door Data and Power Cable. The R20773 Cable leads to the Light/Micro Reader Board (T20601). The -A001 Cable is used for Side A (or Side 1 based on the dispenser). The -A002 Cable is used for Side B (or Side 2 based on the dispenser).

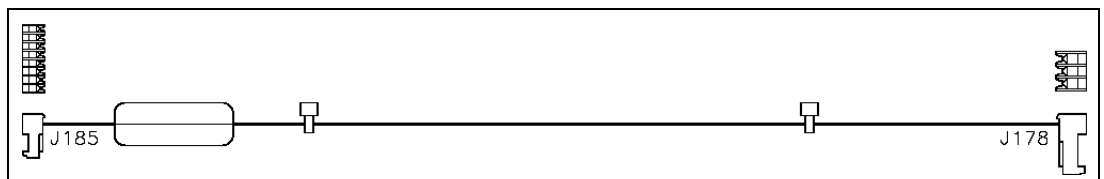
Figure 4-17: Hand-held TRIND System Ribbon Cable



Hand-held TRIND System Power Cable (M01366)

The TRIND Power Cable is a three-wire cable routed between the T20314 Power Supply Assembly and the T20678 Gateway Board.

Figure 4-18: Hand-held TRIND System Power Cable



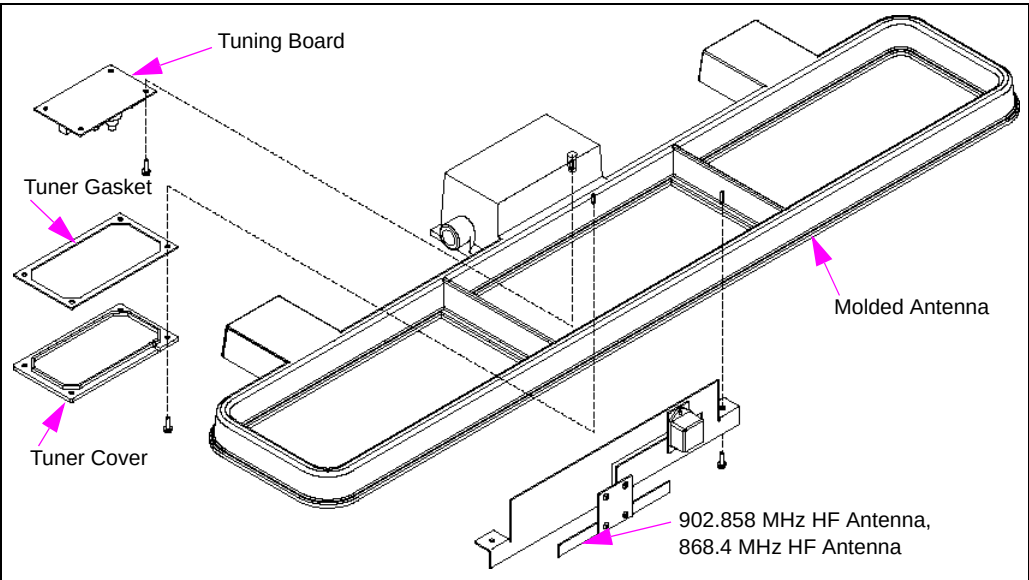
TRIND Overhead Antennas

Full System TRIND has six antennas, four active and two passive. The active antennas can further be divided as transmit only (overhead antennas), and transmit and receive [option door/Customer Interface Module (CIM) door antennas]. All four operate in the LF band at 134.2 kHz. The two passive antennas receive in the UHF Band at 902 MHz (in the US) and at 868 MHz (Asia and Europe), and are used in conjunction with the overhead antennas to utilize the car tags. There are two basic variations of the full system TRIND. The fundamental differences are based on the Card Cage and the overhead antennas used. The antennas can be divided into two sections, the original Mobil antennas (no longer available) and the single-loop antennas, which are currently being shipped with full system TRIND.

Mobil Overhead Antenna Assembly (T20231)

The Mobil overhead antenna assembly consists of a multiple loop (47 uH) coil for LF transmission, a tuning board, and sheet metal slot antenna for UHF receive. This assembly is no longer available, but is still a part of the installed base at Mobil Stations. These antennas have been replaced by the T20632 family of Overhead Antennas.

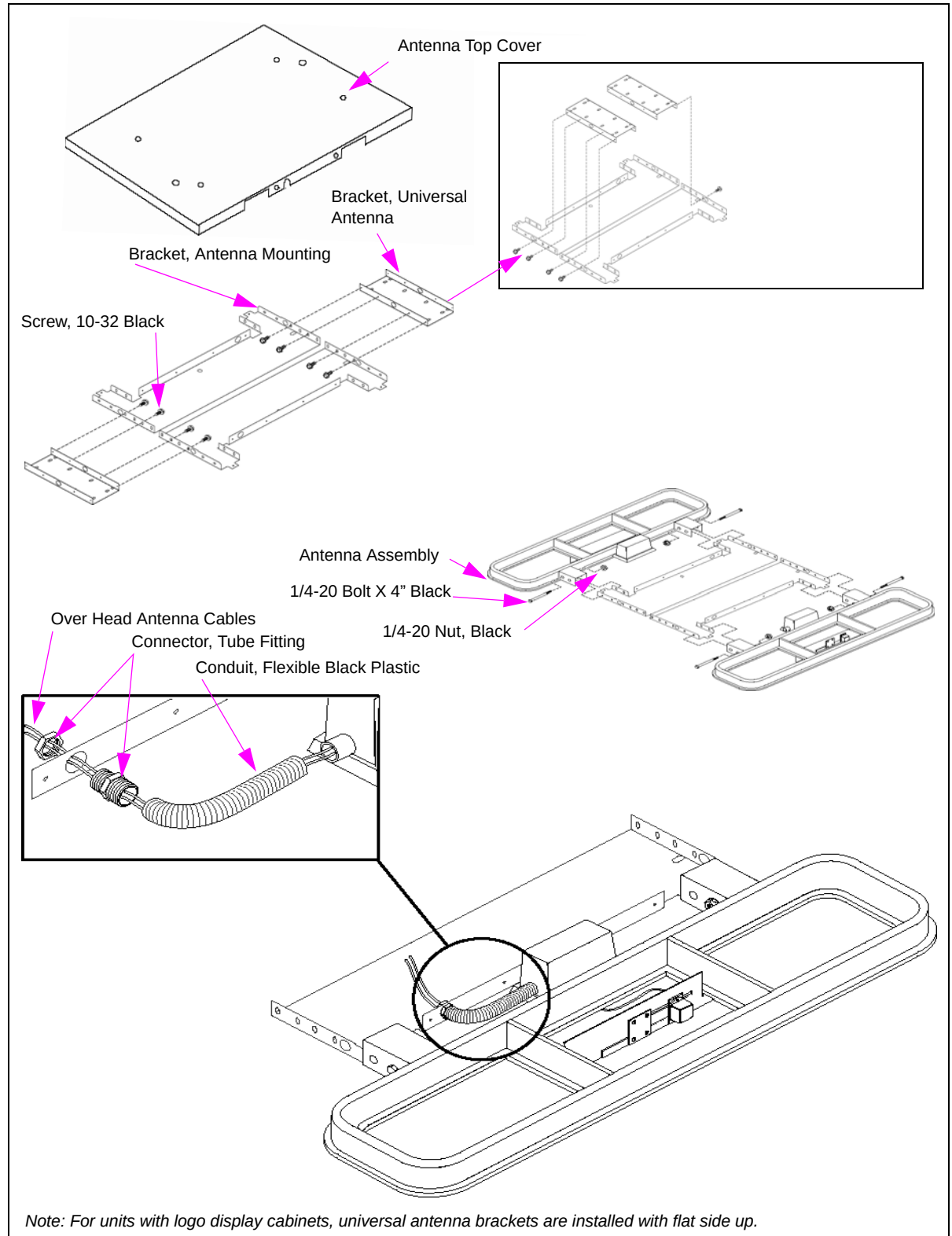
Figure 4-19: Mobil Overhead Antenna Assembly



Mobil Overhead Antenna Assembly

Following table lists the Mobil Overhead Antenna Assembly parts:

Item	Description	Part Number
1	902.858 MHz HF Antenna	Q13580-01
2	868.4 MHz HF Antenna	Q13580-02
3	Molded Antenna	Q13582-01
4	Tuning Board	Q13582-02
5	Tuner Gasket	Q13582-04
6	Tuner Cover	Q13582-03

Figure 4-20: Mobil Overhead Antenna Bracket Assemblies and Hardware

Mobil Overhead Antenna Bracket Assemblies (T20231) and Hardware for The Advantage Series

Following table lists the Mobil Overhead Antenna Bracket Assemblies and hardware for The Advantage Series:

Item	Description	Wide Frame Single-sided	Wide Frame Double-sided	Narrow Frame Single-sided	Narrow Frame Double-sided
1	Antenna Top Cover	T20213-01	T20213-01	T20215-01	T20215-01
2	Bracket, Universal Antenna	T20212-01	T20212-01	T20212-01	T20212-01
3	Bracket, Antenna Mounting	T20211-01	T20211-01	T20211-01	T20211-01
3a	Bracket, Antenna Mounting (see note)	T20211-02	-	T20211-02	-
4	Screw, 10-32 Black	K85736-45	K85736-45	K85736-45	K85736-45
5	Antenna Assembly	T20231-G1	T20231-G1	T20231-G1	T20231-G1
6	1/4-20 Bolt x 4" Black	K01914-70	K01914-70	K01914-70	K01914-70
7	1/4-20 Nut, Black	Q11890-08	Q11890-08	Q11890-08	Q11890-08
8	Over Head Antenna Cables	R20509-G1 Q13578-01	R20509-G1 Q13578-01	R20509-G1 Q13578-01	R20509-G1 Q13578-01
9	Connector, Tube Fitting	Q13591-01	Q13591-01	Q13591-01	Q13591-01
10	Conduit, Flexible Black Plastic	Q13592-02	Q13592-02	Q13592-02	Q13592-02

Note: Not shown on [page 4-16](#), single-sided antenna bracket has no antenna mounting arms.

Mobil Overhead Antenna Bracket Assemblies and Hardware for MPD-3

Following table lists the Mobil Overhead Antenna Bracket Assemblies and hardware for MPD-3:

Item	Description	PMI Bezel Single-sided	PMI Bezel Double-sided	Mack Bezel Single-sided	Mack Bezel Double-sided
1	Antenna Top Cover	T20214-01	T20214-01	T20214-01	T20214-01
2	Bracket, Universal Antenna	T20212-01	T20212-01	T20212-01	T20212-01
3	Bracket, Antenna Mounting	T20211-01	T20211-01	T20211-01	T20211-01
3a	Bracket, Antenna Mounting (see note)	T20211-02	-	T20211-02	-
4	Screw, 10-32 Black	K85736-45	K85736-45	K85736-45	K85736-45
5	Antenna Assembly	T20231-G1	T20231-G1	T20231-G1	T20231-G1
6	1/4-20 Bolt x 4" Black	K01914-70	K01914-70	K01914-70	K01914-70
7	1/4-20 Nut, Black	Q11890-08	Q11890-08	Q11890-08	Q11890-08
8	Over Head Antenna Cables	R20509-G1 Q13578-01	R20509-G1 Q13578-01	R20509-G1 Q13578-01	R20509-G1 Q13578-01
9	Connector, Tube Fitting	Q13591-01	Q13591-01	Q13591-01	Q13591-01
10	Conduit, Flexible Black Plastic	Q13592-02	Q13592-02	Q13592-02	Q13592-02

Note: Not shown on [page 4-16](#), single-sided antenna bracket has no antenna mounting arms.

Single-loop Overhead Antenna Assembly (T20632)

The Single-loop Overhead Antenna Assemblies (T20632-GX) are made up from a single turn (loop) antenna; a high-efficiency tuning board, and a UHF receive antenna. These parts are all mounted in a molded polycarbonate set of boxes and then mounted with brackets on top of the dispenser. These parts are discussed in further in the following sections.

CAUTION

SMA connections should be treated with care and not overtightened. The maximum torque rating on these connectors is usually measured in inch pounds

Too severe a turn or bend in the cable may damage the center conductor or compromise the shield/drain portion of the cable.

This can result in an observance of intermittent reads or other problems. The poor performance will in turn generate a premature field service call. Replacing this cable is labor intensive after the system is installed the first time.

Turns or bends in co-axial cable must be gradual loops, no sharper than a 1-inch radius (2-inch diameter).

CAUTION

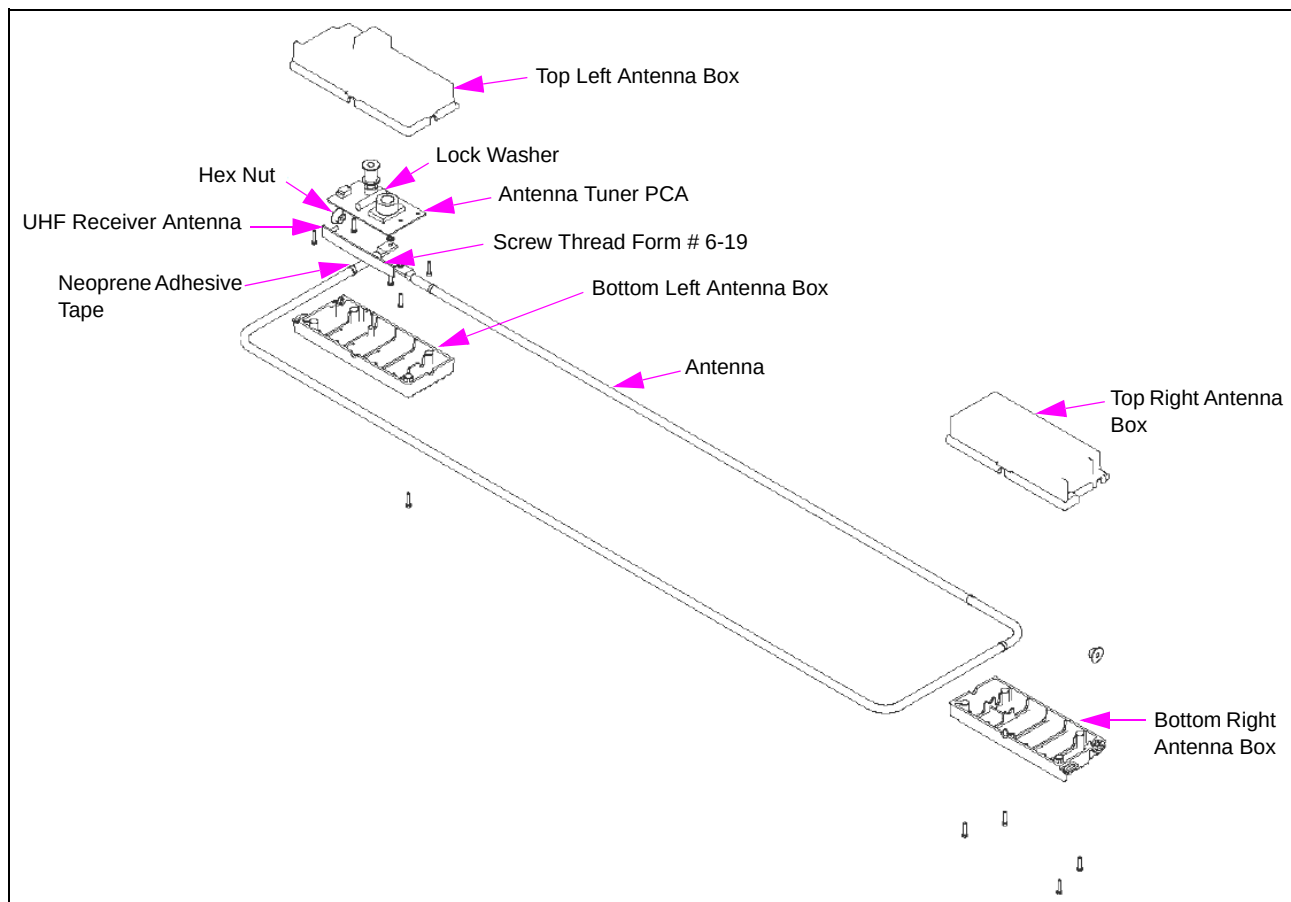
It is critical that the proper tool is used when tuning the overhead antennas on TRIND systems. Only the Q13631-02 [part of Authorized Service Contractor (ASC) Tool Kit K94577-01] plastic tuning tool (or similar plastic 0.10-inch hex tool) should be used for tuning overhead antennas.

Using a metal screwdriver or Allen® wrench has two negative effects. First, a proper tuning is impossible as the metal of the tool used changes the properties of the variable inductor used for tuning. Second, the ferrite slug used in the variable inductor is extremely brittle and is broken or stripped easily by metal tools, preventing the proper tuning of the antenna.

If the antenna is not properly tuned the read range can be significantly reduced.

Note: There are eight different “G” levels of this antenna assembly, due to the different widths and heights of the dispensers.

T20632 “G” Level	Dispenser Antenna is used
G1/G5	Advantage Wide Frame and MPD-3
G2/G6	Advantage Narrow Frame
G3/G7	Encore
G4/G8	Advantage Wide Frame with Exxon® Light Box

Figure 4-21: Single-loop Overhead Antenna Assembly**Single-loop Overhead Antenna Assembly (Domestic)**

Following table lists the Single-loop Overhead Antenna Assembly (Domestic) parts:

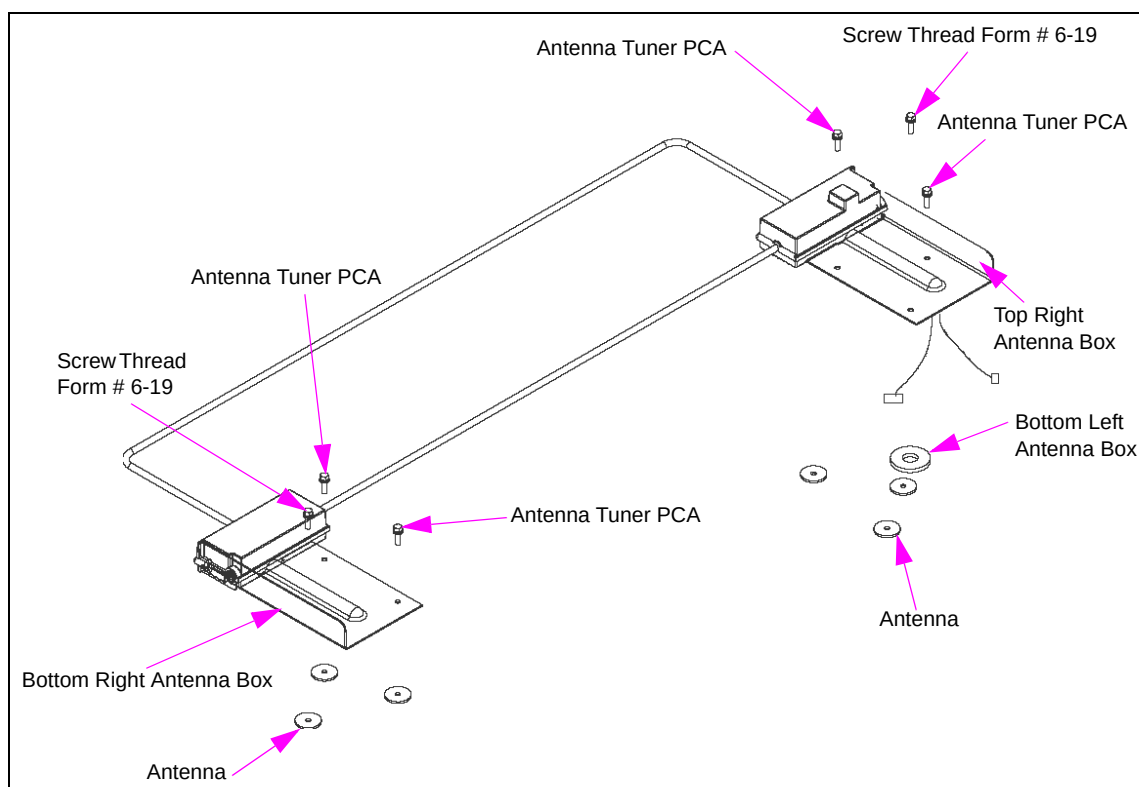
Item	Description	T20632-G1	T20632-G2	T20632-G3	T20632-G4
1	Bottom Right Antenna Box	T20615-04	T20615-04	T20615-04	T20615-04
2	Top Right Antenna Box	T20615-02	T20615-02	T20615-02	T20615-02
3	Antenna	W03889-01	W03889-02	W03889-03	W03889-04
4	Bottom Left Antenna Box	T20615-03	T20615-03	T20615-03	T20615-03
5	Screw Thread Form # 6-19	Q12011-17	Q12011-17	Q12011-17	Q12011-17
6	Antenna Tuner PCA	T20579-G1	T20579-G2	T20579-G3	T20579-G4
7	Lock Washer	K46212	K46212	K46212	K46212
8	Top Left Antenna Box	T20615-01	T20615-01	T20615-01	T20615-01
9	Hex Nut	Q11890-04	Q11890-04	Q11890-04	Q11890-04
10	UHF Receiver Antenna	Q13851-01	Q13851-01	Q13851-01	Q13851-01
11	Neoprene Adhesive Tape	Q11899-12	Q11899-12	Q11899-12	Q11899-12

Single-loop Overhead Antenna Assembly (International)

Following table lists the Single-loop Overhead Antenna Assembly (International) parts:

Item	Description	T20632-G5	T20632-G6	T20632-G7	T20632-G8
1	Bottom Right Antenna Box	T20615-04	T20615-04	T20615-04	T20615-04
2	Top Right Antenna Box	T20615-02	T20615-02	T20615-02	T20615-02
3	Antenna	W03889-01	W03889-02	W03889-03	W03889-04
4	Bottom Left Antenna Box	T20615-03	T20615-03	T20615-03	T20615-03
5	Screw Thread Form # 6-19	Q12011-17	Q12011-17	Q12011-17	Q12011-17
6	Antenna Tuner PCA	T20579-G1	T20579-G2	T20579-G3	T20579-G4
7	Lock Washer	K46212	K46212	K46212	K46212
8	Top Left Antenna Box	T20615-01	T20615-01	T20615-01	T20615-01
9	Hex Nut	Q11890-04	Q11890-04	Q11890-04	Q11890-04
10	UHF Receiver Antenna	Q13851-02	Q13851-02	Q13851-02	Q13851-02
11	Neoprene Adhesive Tape	Q11899-12	Q11899-12	Q11899-12	Q11899-12

Figure 4-22: Single-loop Antenna Brackets and Hardware



Single-loop Antenna Assembly Bracket Kits for The Advantage Series

Following table lists the Single-loop Antenna Assembly Bracket Kits for The Advantage Series parts:

Item	Description	W/F & N/F RID Plus Exxon (K96647-01)	With Canopy (K96647-02)	With Or With Out Blue Hats (K96647-03)	With Milwaukee Light Box (K96647-06)
1	Antenna Bracket, Left	T20623-01	T20624-01	-	-
2	Antenna Bracket, Right	T20623-02	T20624-02	-	-
1	Antenna Bracket, W/F & N/F	-	-	T20625-01	-
2	Antenna Bracket, W/F & N/F	-	-	T20625-02	-
1	Antenna Bracket, ADV & MPD-3	-	-	-	T20628-01
2	Antenna Bracket, ADV & MPD-3	-	-	-	T20628-02
3	Gasket, Mounting Bracket	N23958-01	N23958-01	N23958-01	N23958-01
4	Gasket, Antenna Wire Bracket	N23959-01	N23959-01	N23959-01	N23959-01
5	Screw, Hex Head	Q11889-104	Q11889-104	Q11889-104	Q11889-104
6	Fastener, Self-Drilling	-	-	-	Q13897-01

Single-loop Antenna Assembly Bracket Kits for MPD-3 Series

Following table lists the Single-loop Antenna Assembly Bracket Kits for MPD-3 Series parts:

Item	Description	With Canopy (K96647-04)	With Out Canopy (K96647-05)	With Milwaukee Light Box (K96647-06)
1	Antenna Bracket, Left	T20626-01	T20627-01	-
2	Antenna Bracket, Right	T20626-02	T20627-02	-
1	Antenna Bracket, ADV and MPD-3	-	-	T20628-01
2	Antenna Bracket, ADV and MPD-3	-	-	T20628-02
3	Gasket, Mounting Bracket	N23958-01	N23958-01	N23958-01
4	Gasket, Antenna Wire Bracket	N23959-01	N23959-01	N23959-01
6	Screw, Hex Head	Q11889-104	Q11889-104	Q11889-104
6	Fastener, Self-Drilling	-	-	Q13897-01

Single-loop Antenna Assembly Bracket Kit for Encore Unit

Following table lists the Single-loop Antenna Assembly Bracket Kits for Encore units parts:

Item	Description	K96647-07
1	Antenna Bracket, Encore	T20630-01
2	Antenna Bracket, Encore	T20630-02
3	Gasket, Bracket Mounting	N23958-01
4	Gasket, Antenna Wire Bracket	N23959-01
5	Screw, Hex Head	Q11889-104

UHF Antenna (Q13851-01 and Q13851-02)

This antenna is specifically used to receive the UHF response from the vehicle mount tag. It has a “pigtail” RG-316 co-axial cable with a SMA jack on the other end connected to it for ease of manufacture and installation purposes. Q13851-01 is intended for domestic use and is found in the T20632-G1 Card Cage through Single Loop Antenna Assemblies (T20632-G4). Q13851-02 is intended for international use and is found in the T20632-G5 Card Cage through Single-loop Antenna Assemblies (T20632-G8).

Antenna Tuning Board (T20579-GX)

The Antenna Tuning Board (T20579-GX) allows the resonance tuning of the low frequency downlink antenna to match with the Transmitter Module to compensate for product tolerances at manufacturing, and to achieve the maximum field strength. The antenna circuit is tuned to resonance by adjusting the ferrite core of the on-board coil with a 0.10-inch hex tuning tool located in ASC TRIND Tool Kit.

IMPORTANT INFORMATION

The “G” level of this board must match the “G” level of the final assembly. Capacitance values are different between the boards due to the different sizes of the single loop antenna itself.

TRIND Option Doors with Antennas

This section provides descriptions and parts information for TRIND options contained in the doors of The Advantage Series, MDP-3, Encore, and Eclipse dispensers. This version of TRIND consists of RFID components, including the antenna, mounted on the door. The antennas used for the option doors on The Advantage Series and Encore/Eclipse, perform transmit and receive functions and interact directly with a Micro Reader that’s contained on a light board located in the door. The inductive antennas utilize the magnetic near field (air interface) generated by the Micro Reader to interact with the hand-held tags.

The Light Micro Reader PCA (T20601-G1/G2) is used on the The Advantage Series and MPD-3 dispensers. The T20601-G1 Board has red Light Emitting Diode (LEDs), the T20601-G2 Board has orange LED’s. The LEDs light to provide an indication to the consumer that the key tag has been read. In addition, the board processes data received from the key tag antenna, and sends the processed data to the DCB or Enhanced Gateway Board.

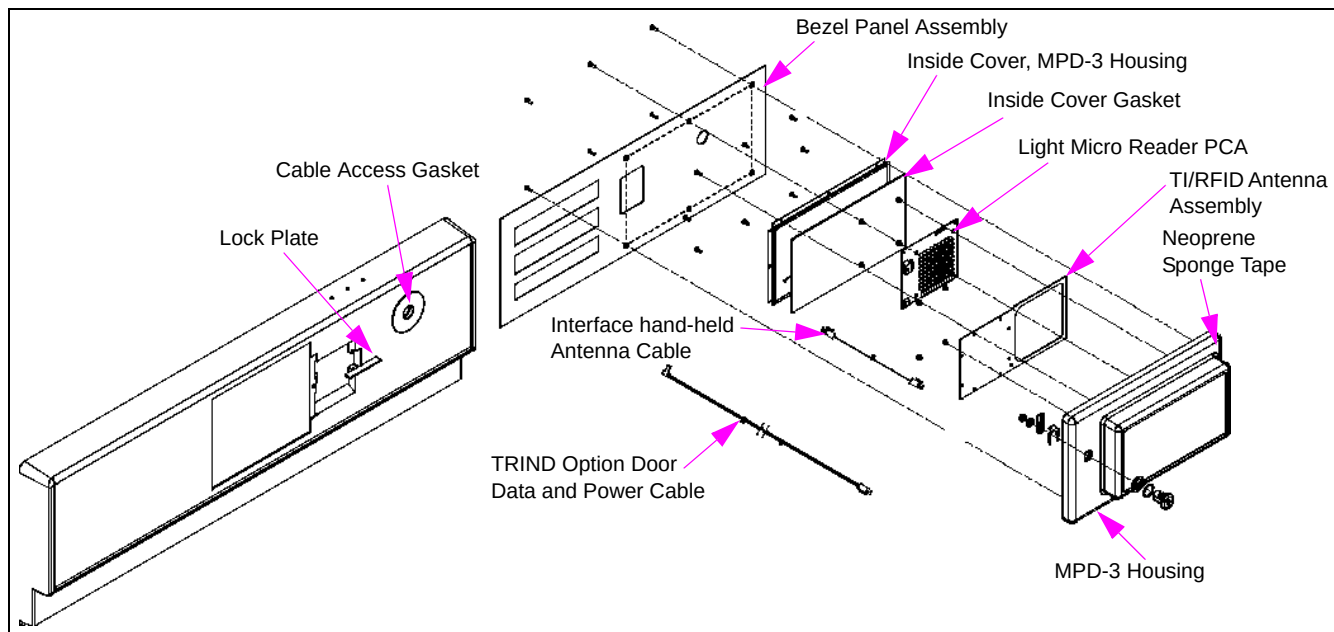
The Key-tag Antenna (T20524-G1) is used on The Advantage Series and MPD-3 dispensers. It connects to the T20601-GX PCA, and is used as an antenna for the key tag portion of the system. An R20522-G2 Cable provides a connection between the T20524 and T20601 PCAs.

The Light Micro Reader/Antenna PCA (M01218A001/M01218A002) is used on the Encore/Eclipse dispensers. The M01218A001 Board has red LEDs, M01218A002 Board has orange LED’s. The board provides indication to the consumer that the tag has been read. In addition, the board processes data received from the key tag antenna, and sends the process data to the DCB or Enhanced Gateway Board. The antenna for key-tag portion of the system has been integrated into this assembly. This board also has the ability to be reconfigured from red to orange LEDs, and vice versa, in the field.

MPD-3 Bezel Assemblies (T20616)

The following sections provide parts information for the MPD-3 Bezel Assemblies.

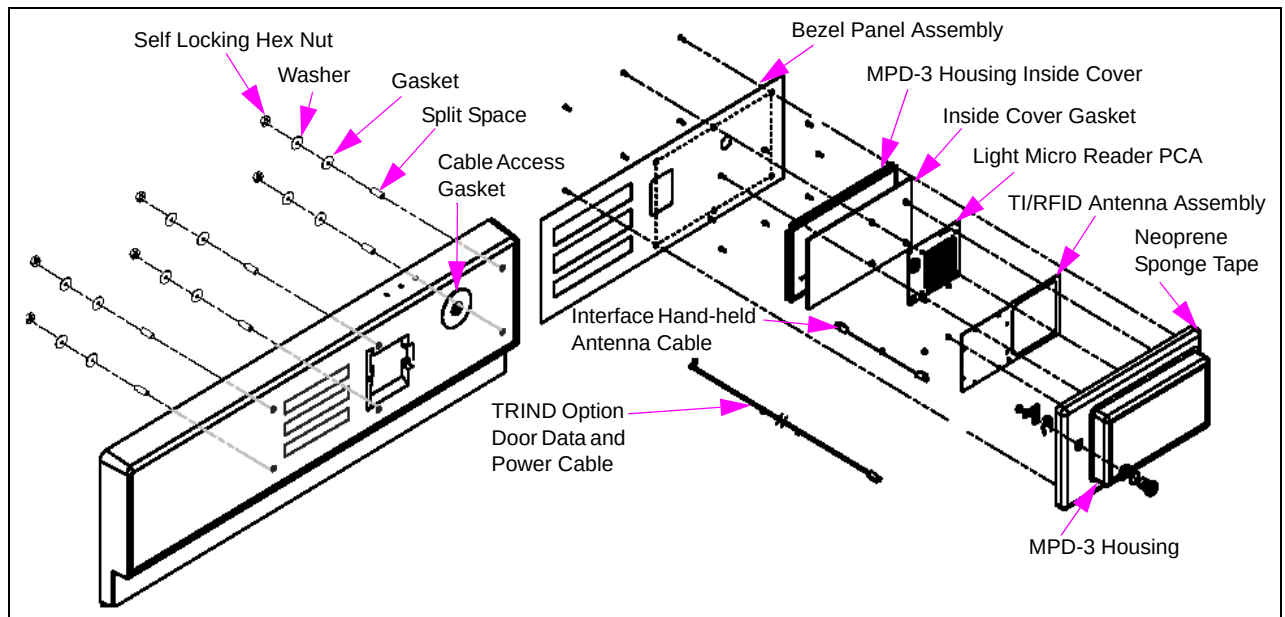
Figure 4-23: MPD-3 Bezel Assembly (T20616-G1)



MPD-3 Bezel Assembly

Following table lists the MPD-3 Bezel Assembly parts:

Item	Description	Part Number
1	Housing, MPD-3	T20417-G1
2	Tape, Single Coated Neoprene Sponge	Q11899-02
3	TI/RFID Antenna Assembly	T20524-G1
4	Light Micro Reader PCA	T20601-G1
5	Inside Cover Gasket	R20584-01
6	Inside Cover, MPD-3 Housing	T20216-01
7	Bezel Panel Assembly	T17446-G8
8	Interface Hand-held Antenna Cable	R20522-G2
9	TRIND Option Door Data and Power Cable	R20773-G2
10	Cable Access Gasket	N23881-01
11	Plate, Lock	N23873-G1

Figure 4-24: MPD-3 Bezel Assembly (T20616-G2)

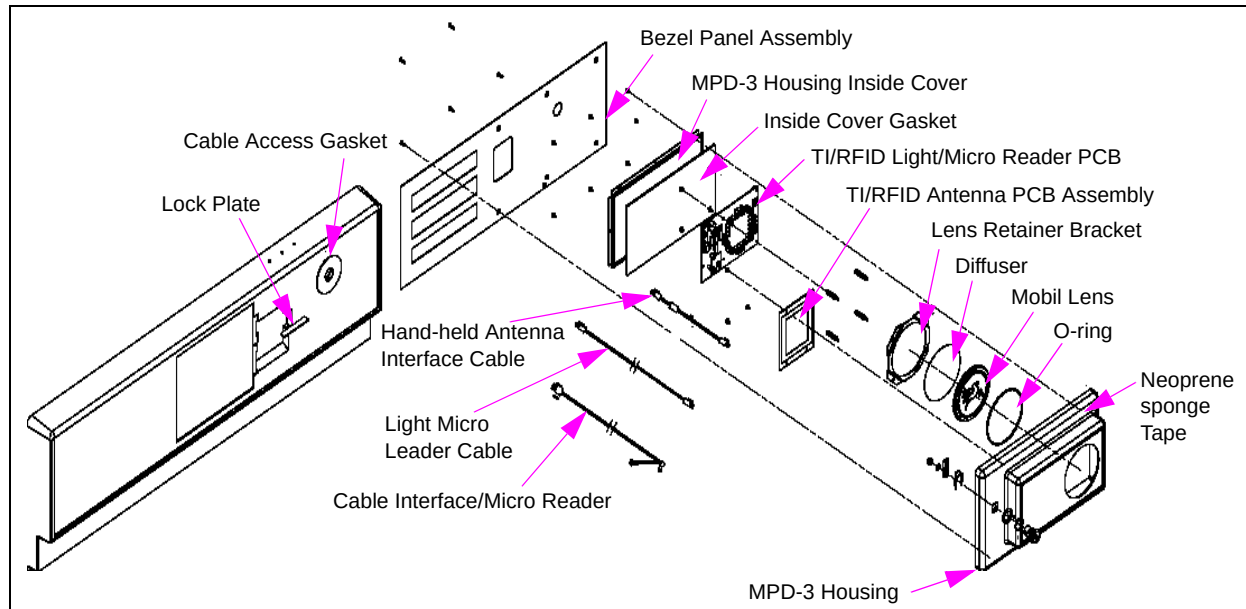
MPD-3 Bezel Assembly

Following table lists the MPD-3 Bezel Assembly parts:

Item	Part Description	Part Number
1	Housing, MPD-3	T20179-01
2	Tape, Single Coated Neoprene Sponge	Q11899-02
3	TI/RFID Antenna Assembly	T20524-G1
4	Light Micro Reader PCA	T20601-G1
5	Inside Cover Gasket	R20584-01
6	Inside Cover, MPD-3 Housing	T20216-01
7	Bezel Panel Assembly (see note 1)	T17534-G05
8	Interface Hand-held Antenna Cable	R20522-G2
9	TRIND Option Door Data and Power Cable	R20773-G2
10	Cable Access Gasket	N23881-01
11	Spacer, Split (see note 2)	K87404-01
12	Gasket, 0.88 O.D. (see note 2)	Q11659-01
13	Washer (see note 2)	N16599-78
14	Nut, Self Locking Hex (see note 2)	Q10218-01

Notes:

1. Bolt-on Panel for Mack Bezels.
2. Bezel Assembly requires a quantity of six (6).

Figure 4-25: MPD-3 Bezel Assembly**MPD-3 Bezel Assembly**

Following table lists the MPD-3 Bezel Assembly parts:

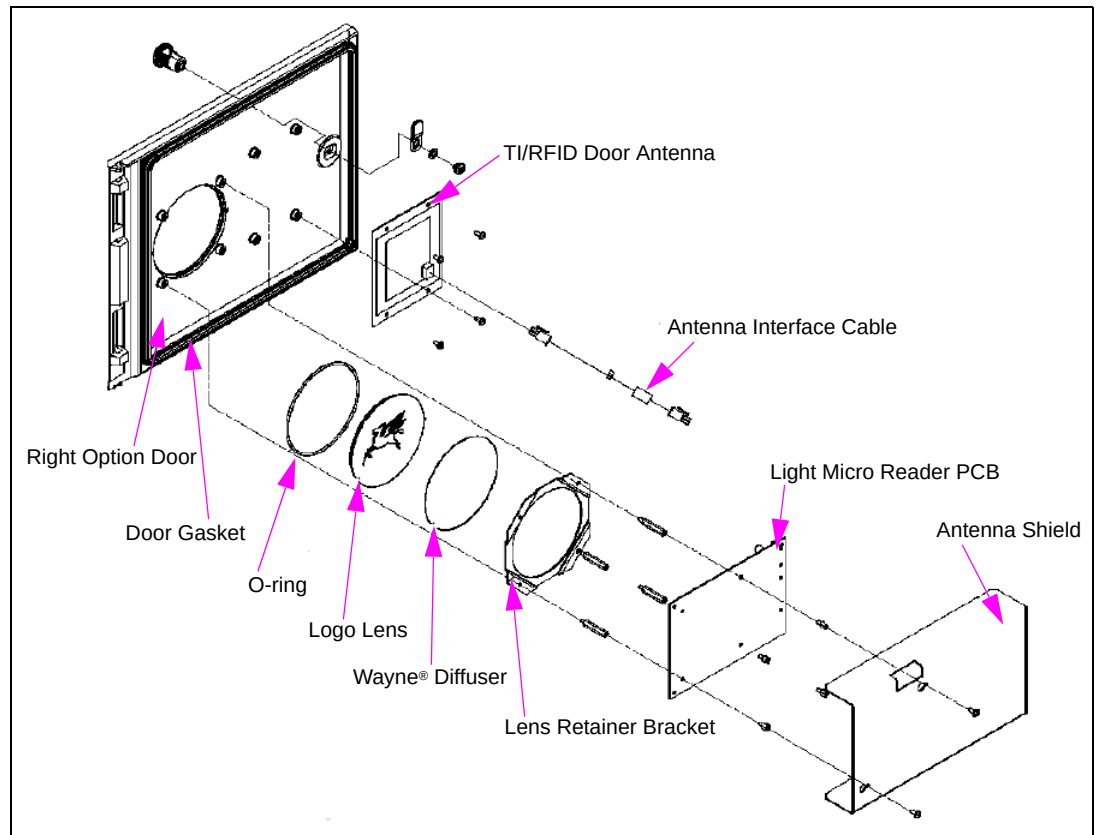
Item	Part Description	Part Number
1	Housing, MPD-3	T20179-01
2	Tape, Single Coated Neoprene Sponge	Q11899-02
3	O-ring, 4.25 X 4.28	Q13575-02
4	Lens, Mobil	Q13575-01
5	Diffuser	Q13575-03
6	Bracket, Lens Retainer	Q13575-04
7	TI/RFID Antenna PCB Assembly	T20143-G1
8	TI/RFID Light/Micro Reader PCB	T20446-G1
9	Gasket, Inside Cover	R20584-01
10	Inside Cover, MPD-3 Housing	T20216-01
11	Bezel Panel Assembly	T17446-G8*
12	Gasket, Cable Access	N23881-01
13	Plate, Lock	N23873-G1
14	Cable, Hand-held Antenna Interface	R20522-G1
15	Cable, Light Micro Reader	R20519-G3
16	Interface/Micro Reader, Cable	R20521-G3

*Slide-in panel for PMI bezels.

Advantage Wide Frame Option Door Assemblies

This section provides parts data for The Advantage Series Wide Frame Option Doors Assemblies.

Figure 4-26: Advantage Wide Frame (48 inches) Option Door Assembly

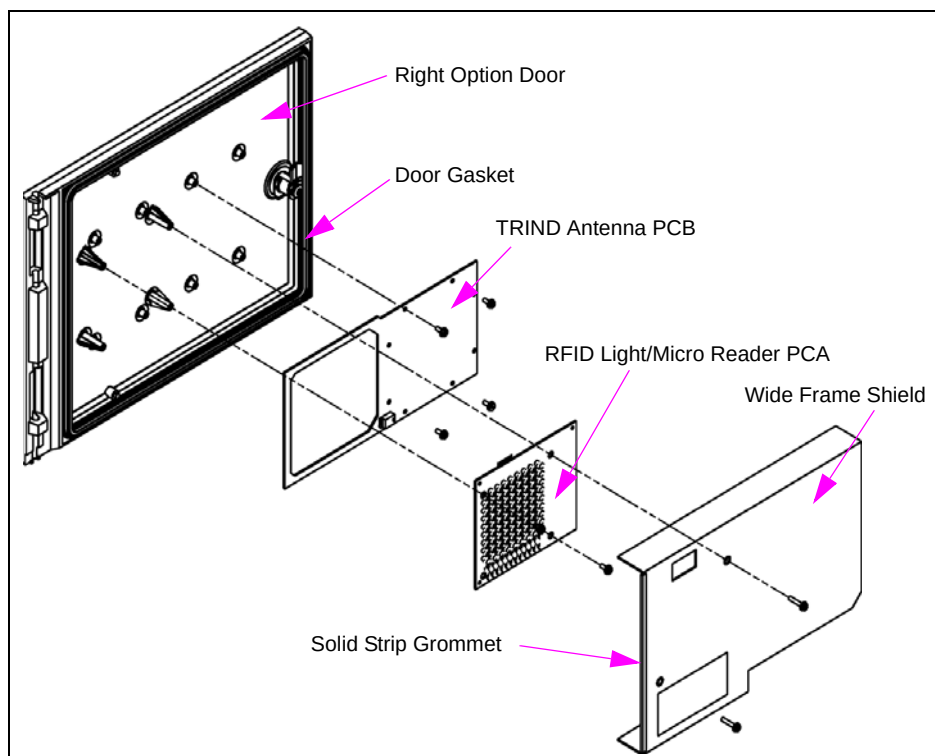


Advantage Wide Frame Option Door Assembly

Following table lists The Advantage Series Wide Frame Option Door Assembly parts:

Item	Part Description	Part Number
1	TI/RFID Door Antenna	T20143-G1
2	Light Micro Reader PCB*	T20446-G1
3	Antenna Shield	T20210-01
4	Lens Retainer Bracket	Q13575-04
5	Diffuser, Wayne	Q13575-03
6	Logo Lens	Q13575-01
7	O-ring	Q13575-02
8	Door Gasket	R20424-01
9	Option Door, Right	T17499-06
10	Antenna Interface Cable	R20522-G1

*Replaced T20182-G1 and T20295-G1.

Figure 4-27: Advantage Wide Frame (48 inches) Option Door Assembly**Advantage Wide Frame Option Door Assembly Parts List**

Following table lists the Advantage Wide Frame Option Door Assembly parts:

Item	Part Description	Part Number
1	Wide Frame Shield	T20570-G1
2	Solid Strip Grommet	Q10315-06
3	RFID Light/Micro Reader PCA (see note 1)	M01580A00X
4	TRIND Antenna PCB	T20524-G1
5	Door Gasket	R20424-01
6	Right Option Door (see note 2)	T20415-0X

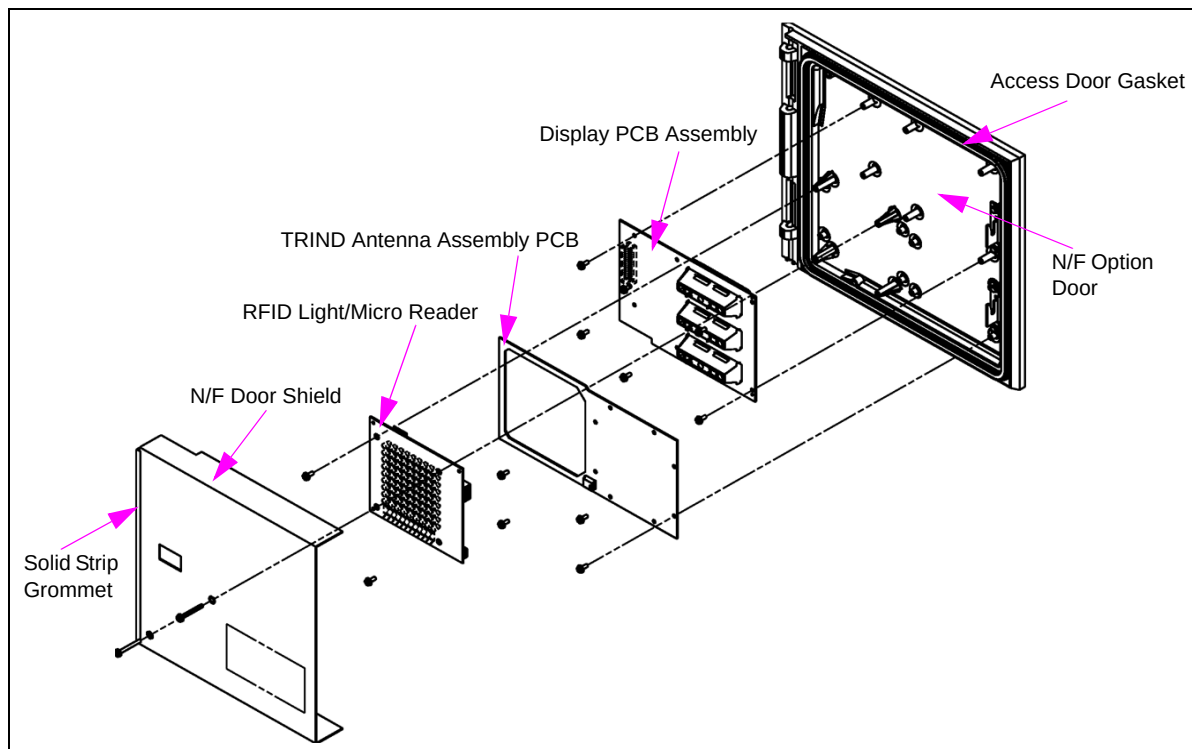
Notes:

1. Order entry item available as -A001 and -A002.
2. Order entry item available as -01 through -08.

Advantage Narrow Frame Option Door Assemblies

This section provides parts data for The Advantage Series Narrow Frame Option Doors.

Figure 4-28: The Advantage Series Narrow Frame (36 inches) Option Door Assembly

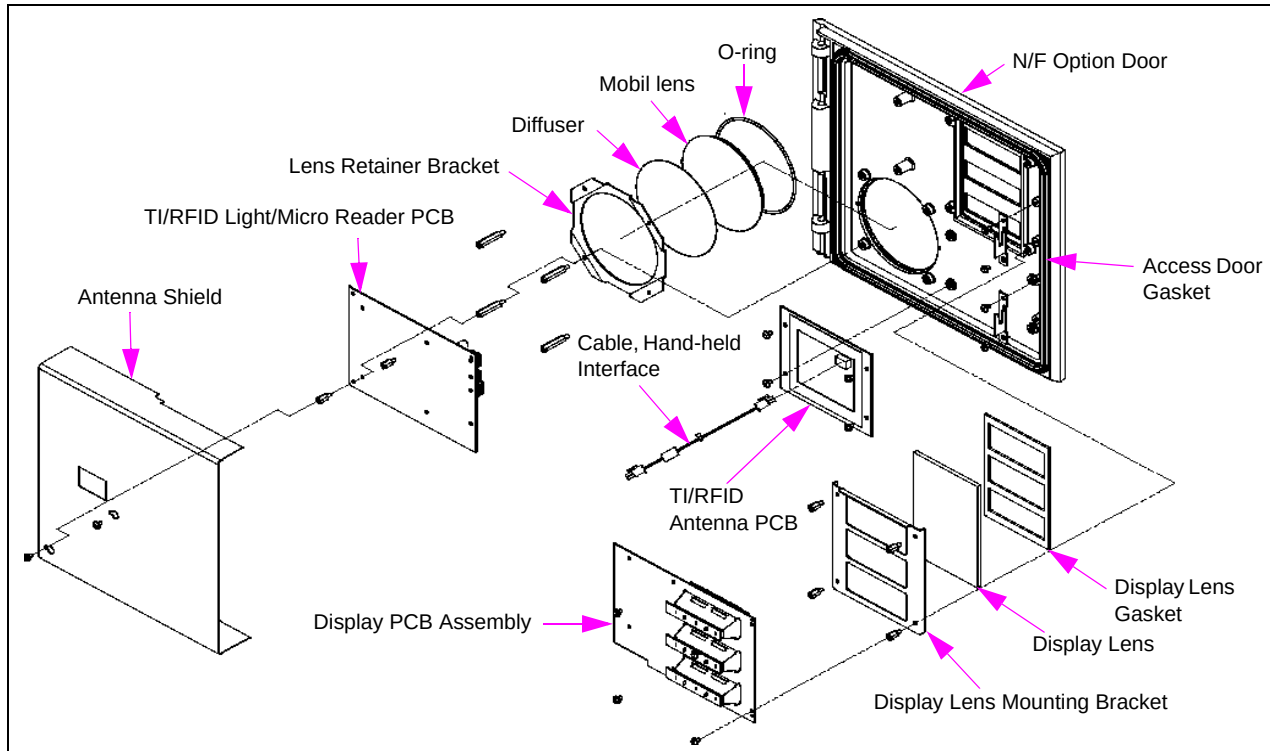


Narrow Frame Option Door Assembly

Following table lists the Narrow Frame Option Door Assembly parts:

Item	Part Description	Part Number
1	Solid Strip Grommet	Q10315-06
2	N/F Door Shield	T20571-G1
3	RFID Light/Micro Reader*	M01580A00X
4	TRIND Antenna Assembly PCB	T20524-G1
5	Display PCB Assembly	T20262-G1
6	Access Door Gasket	R20424-01
7	N/F Option Door	T20416-01

*Order entry item available as -A001 and -A002.

Figure 4-29: The Advantage Series Narrow Frame (36 inches) Option Door Assembly

Narrow Frame Option Door Assembly

Following table lists the Narrow Frame Option Door Assembly parts:

Item	Part Description	Part Number
1	N/F Option Door (see note 1)	T20125-0X
2	O-ring	Q13575-02
3	Mobil lens	Q13575-01
4	Diffuser	Q13575-03
5	Lens Retainer Bracket	Q13575-04
6	TI/RFID Light/Micro Reader PCB (see note 2)	T20446-G1
7	Antenna Shield	T20210-02
8	Cable, Hand-held Interface	R20522-G1
9	Display PCB Assembly	T20262-G1
10	TI/RFID Antenna PCB	T20143-G1
11	Display Lens Mounting Bracket	R20586-01
12	Display Lens	R20585-01
13	Display Lens Gasket	N23879-01
14	Access Door Gasket	R20424-01

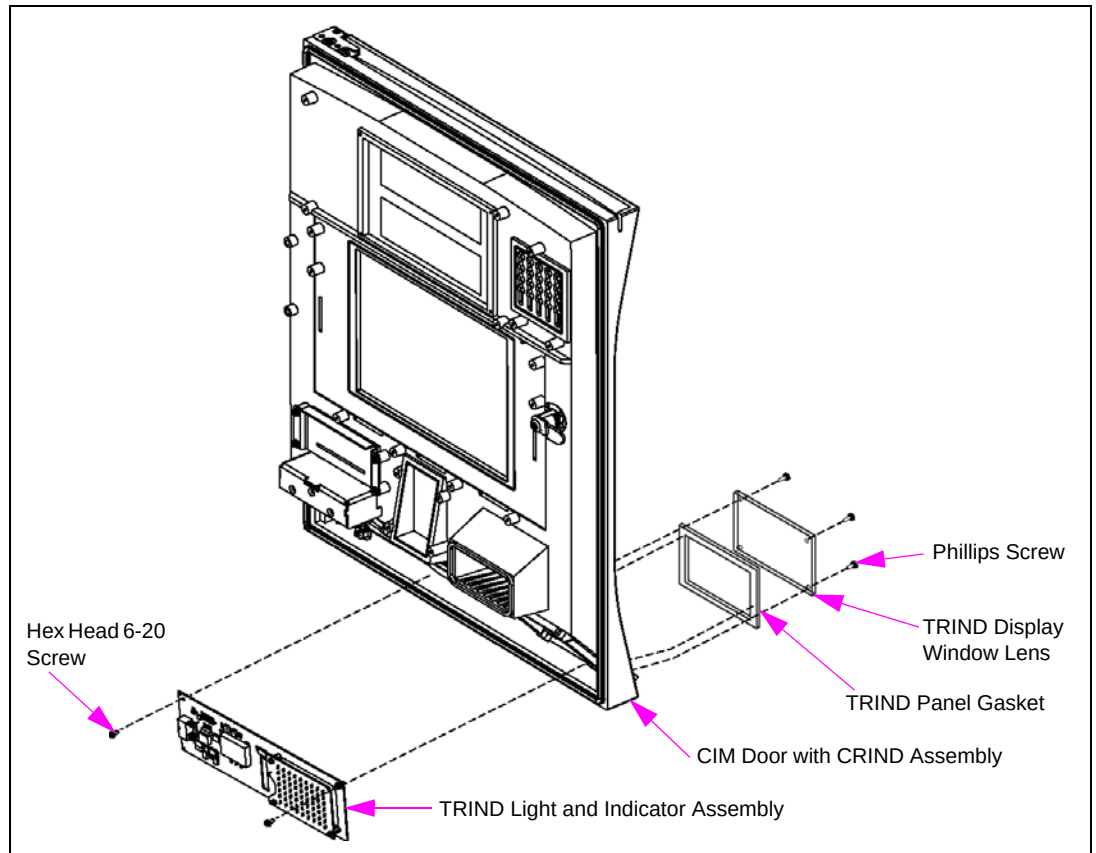
Notes:

1. Order entry item available as -01 and -02.
2. Replaced T20295-G1.

Encore CIM Door Option Assembly

This section provides the parts for the Encore CIM Door Option Assembly.

Figure 4-30: Encore CIM Door Option Assembly



Encore CIM Door Option Assembly Parts List

Following table lists the Encore CIM Door Option Assembly parts:

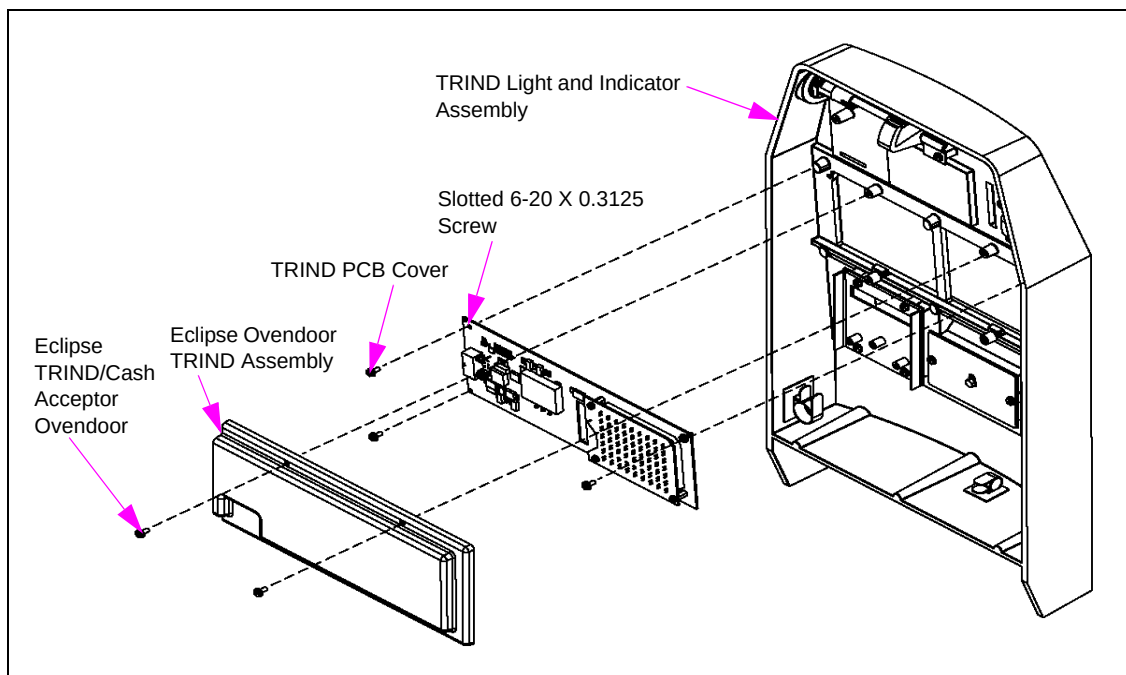
Item	Part Description	Part Number
1	Screw, Hex Head 6-20	Q11677-24
2	TRIND Light and Indicator Assembly	M01218A00X*
3	CIM Door with CRIND Assembly	M01208A001
4	TRIND Panel Gasket	M01160B001
5	TRIND Display Window Lens	M01234B001
6	Screw, Phillips®	M00419B117

*Order entry item available as red (-A001) or orange (-A002).

Eclipse Ovendoor Option Assembly

This section provides the parts for the Eclipse Ovendoor Option Assembly.

Figure 4-31: Eclipse Ovendoor Option Assembly



Eclipse Ovendoor Option Assembly Parts List

Following table lists the Eclipse Ovendoor Option Assembly parts:

Item	Part Description	Part Number
1	Eclipse TRIND/Cash Acceptor Ovendoor	M01509A001
2	Eclipse Ovendoor TRIND Assembly	M01661A001
3	TRIND PCB Cover	M01408B001
4	Slotted 6-20 X 0.3125 Screw	Q11677-23
5	TRIND Light and Indicator Assembly	M01218A00X*

*Order entry item available as red (-A001) or orange (-A002).

Light/Micro Reader PCB (T20446-G1, T20601-GX, M01580A001, and M01580A002)

Note: T20446 replaced Light/Micro Reader PCB T20182-G1 and T20295-G1. M01580A001 and M01580A002 replaced Light/Micro Reader PCB T20601-G1 and G2.

The PCB is mounted on the right options door on The Advantage Series units or in an enclosure mounted on the bezel for MPD-3 units. The PCB processes data received from the hand-held transponder and provides tag read indicator lights for the TRIND system. The PCB requires both 5 VDC and 22.5 VDC supplied at P182 plug. The PCB also provides hand-held transmitter information to the DCB or Enhanced Gateway Board. In addition, the PCB receives information regarding light control from the DCB. These activities are also done through P182 plug.

Figure 4-32: T20446-G1 Light/Micro Reader PCB

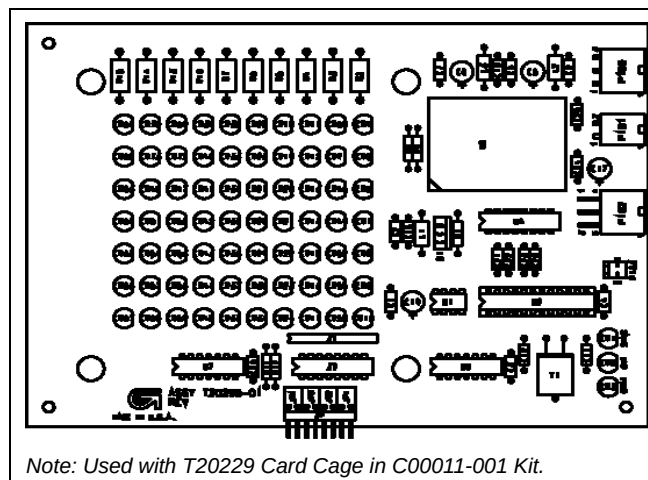


Figure 4-33: T20601-G1 Light/Micro Reader PCB

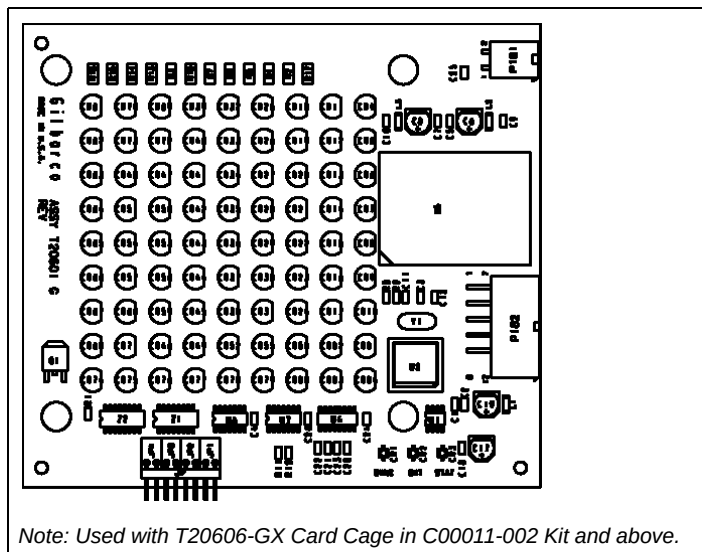
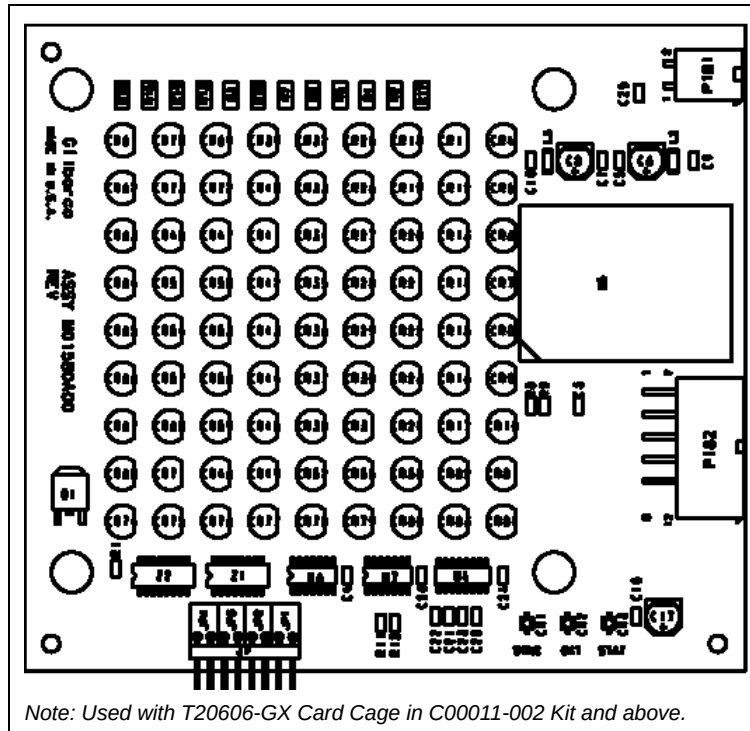


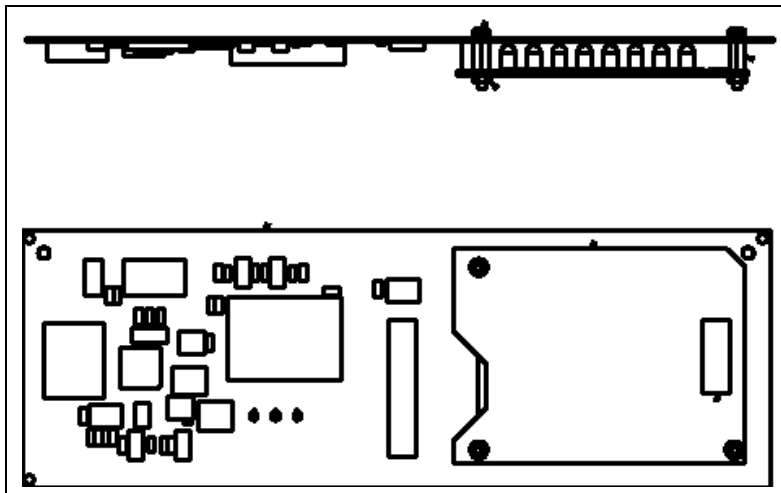
Figure 4-34: M01580A00X Light/Micro Reader PCB



M01218A001 and M01218A002 Light/Micro Reader PCB

Mounted on the CIM Door on Encore and Eclipse units, this PCB processes information received from hand-held transponder (only), as well as provides indicator lights for the TRIND system. The PCB requires both 5 VDC and 22.5 VDC supplied at P182 plug. The PCB provides transmitter activity data to the DCB, and receives light control information from the DCB. These activities are done through P182 plug. The antenna is integrated into this assembly.

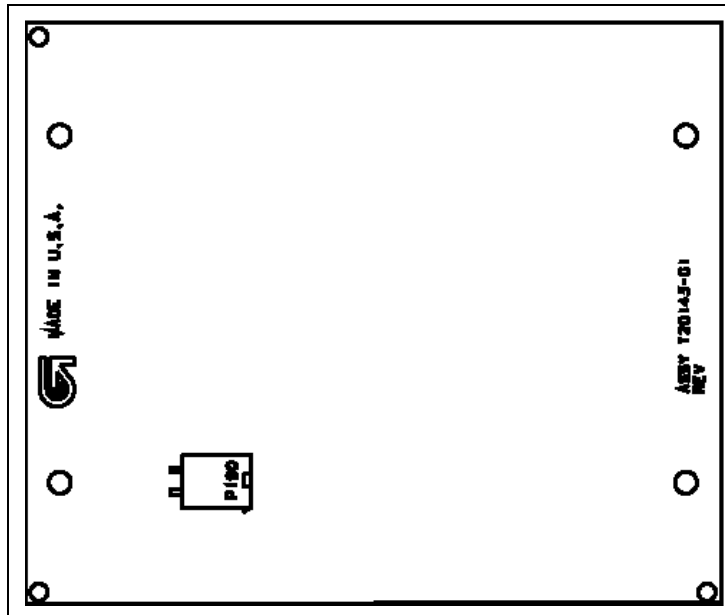
Figure 4-35: M01218A00X Light/Micro Reader PCB



Hand-held Antenna PCB (T20143-G1)

Hand-held PCB is used on the original system and is connected to Light/Micro Reader PCB (T20182) at P181 plug and mounted on options or bezels doors.

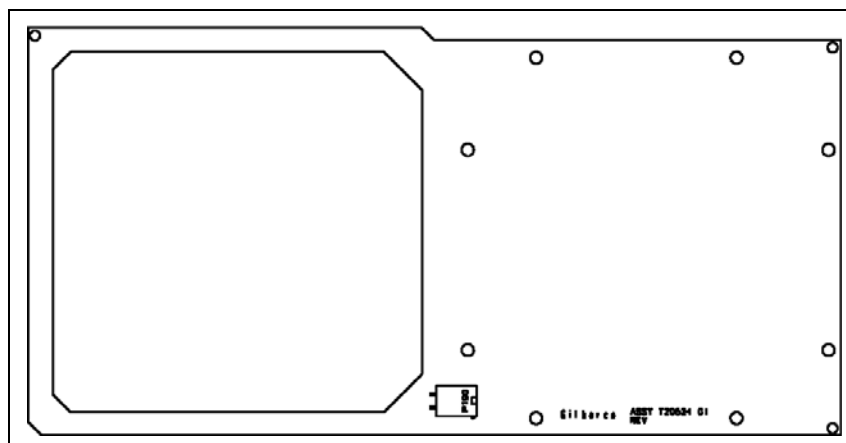
Figure 4-36: Hand-held Antenna PCB



TRIND Antenna PCA (T20524-G1)

The PCAs are 47uH antennas that work with the Micro Reader. They are energized by the Micro Reader at 132 kHz to generate the exciter frequency of 134.2 kHz.

Figure 4-37: TRIND Antenna PCA



System Cables

This section provides a description and parts information for the TRIND system cables. These cables are used to make connections between the various TRIND and dispenser components that comprise the TRIND system.

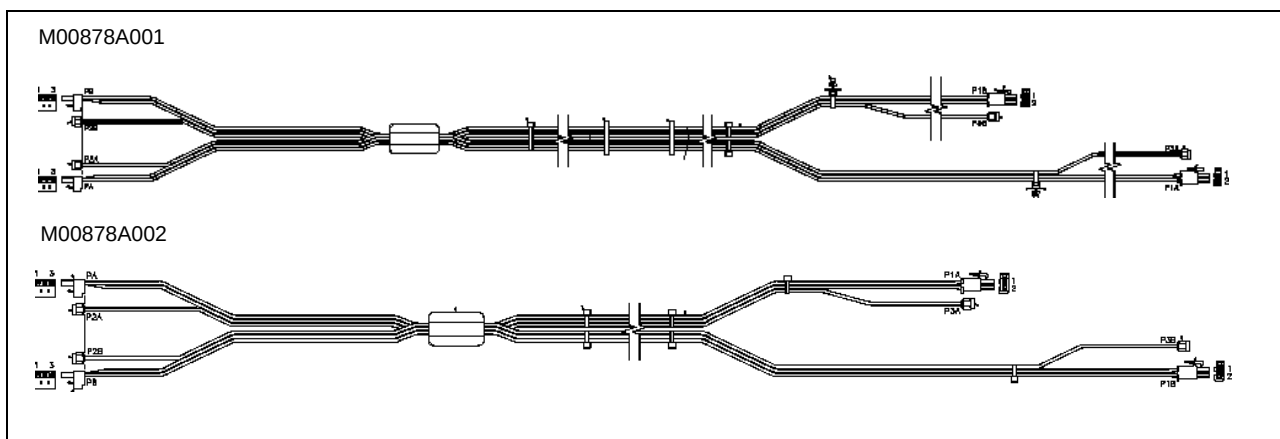
Note: To ensure compliance with EMC® standards, do not remove the ferrite beads from cable assemblies provided with them.

L/HF Antenna Cable (M00878)

The Overhead Antenna Cable Assemblies (M00878A001 and M00878A002), connect the overhead antennas to the TRIND UHF receiver and LF transmitter. The M00878A001 Cable is used for the Encore units, the M00878A002 is used for The Advantage Series and MPD-3 units.

Note: If the unit has an Exxon Lightbox, an overhead Antenna Cable Extension (M01380A001) used for this configuration.

Figure 4-38: L/HF Antenna Cable

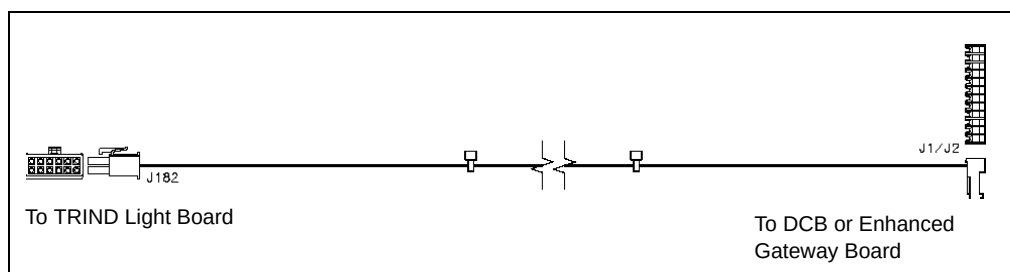


Power and Data Option Door Cable (R20773)

The Power and Data Option Door Cable connects the Light/Micro Reader PCA to the TRIND Card Cage.

Note: This cable exists in some quantities as 55 inches long. This was eventually changed to 70 inches long (Revision C and above). If you encounter the shorter version, you need an Extender Cable (M01557A001) for each side of the dispenser.

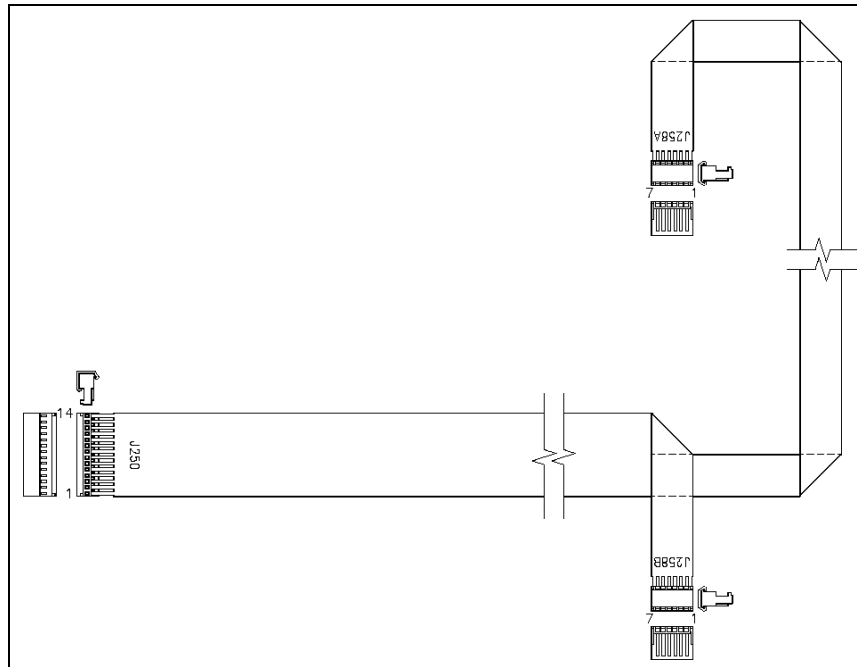
Figure 4-39: Power and Data Option Door Cable



R20437-G01 TRIND to CRIND Logic Cable (The Advantage Series and MPD-3)

The R20437-G01 TRIND to CRIND Logic Cable connects the TRIND Gateway Boards (T20128 and T20678) to CRIND Logic Boards.

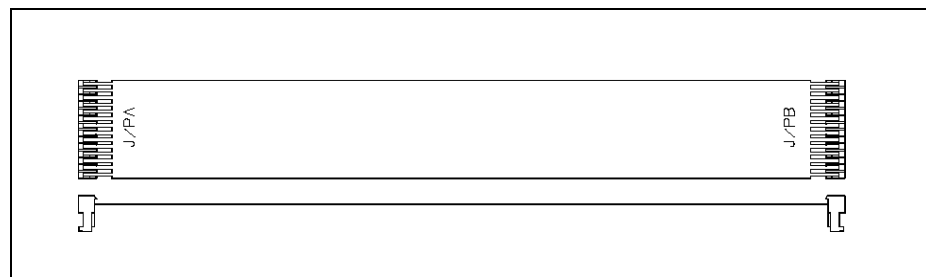
Figure 4-40: R20437-G01 TRIND to CRIND Logic Cable



M00515A002 TRIND to CRIND Logic Cable for Encore 500 and Eclipse

The M00515A002 TRIND to CRIND Logic Cable for Encore 500 and Eclipse connects the Gateway Boards to the CRIND Logic Boards.

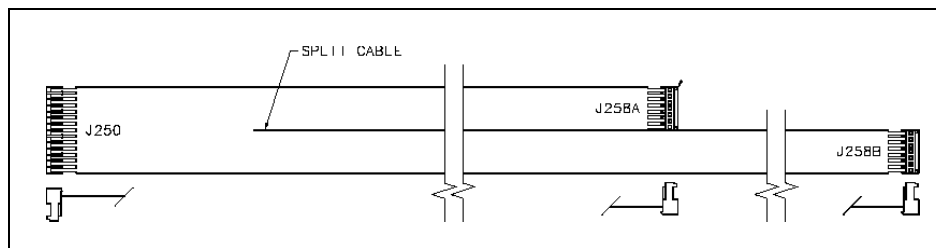
Figure 4-41: M00515A002 TRIND to CRIND Logic Cable



M001804A001 TRIND to CRIND Logic Cable for Encore 300

The M001804A001 TRIND to CRIND Logic Cable for Encore 300 connects the Gateway Boards to the CRIND Logic Boards.

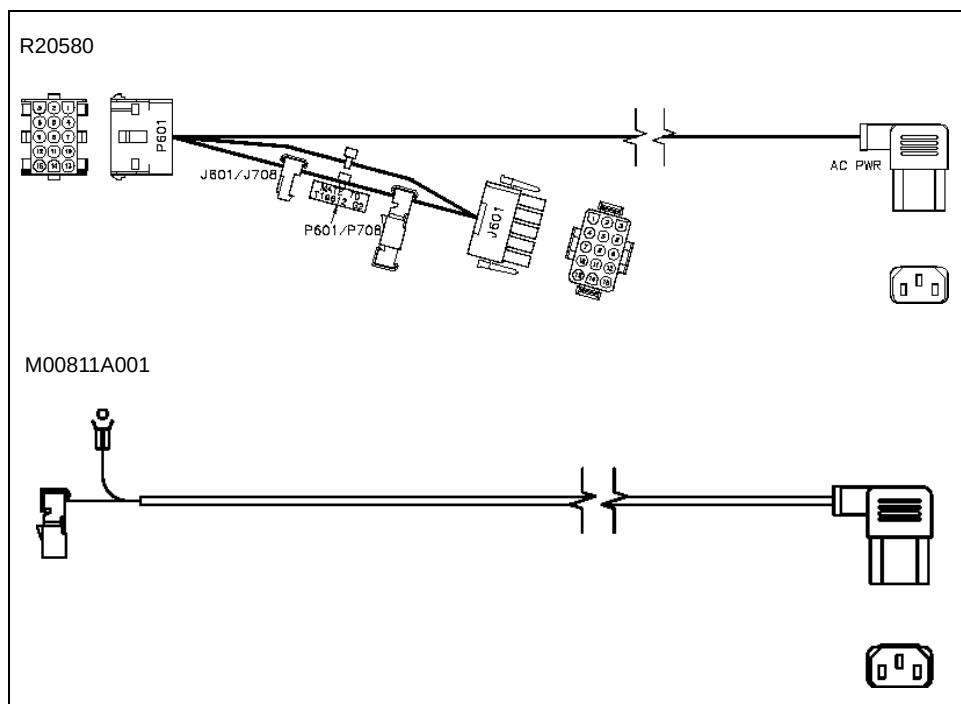
Figure 4-42: M001804A001 TRIND to CRIND Logic Cable



AC Power Cables (R20580 and M00811A001)

The AC Power Cables are used to provide system power to the TRIND Card Cage assembly. Connections for these cables are unit specific. Use appropriate connector to intercept power on existing unit power cable.

Figure 4-43: AC Power Cables



Full System Cable Connections on Legacy and Advantage Series Dispensers

For all single-sided units, install Dummy Load Connector (R20526-01) on JB on transmitter PCB and skip all Side B connections.

Note: If power is applied to Card Cage without the antenna cables or dummy load connected, the transmitter board will be damaged.

On Cable	Connect	To	On
R20509-G2 (marked for Side A)	P1/2	J1	Side A Overhead Antenna (low frequency)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked for Side B)	P1/2	J2	Side B Overhead Antenna (low frequency)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G1	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	P7	*J7	DCB PCB Q13563
R20519-G2	J182	P182	Light/micro Reader Pcb Assembly T20182 on Side B Options Door
	P8	*J8	DCB PCB Q13563
R20521-G1	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	J177	*P177	Power supply PCB T20138
	GRD	*Ground Stud	Card Cage
R20521-G2	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	J176	*P176	Power Supply PCB T20138
	GRD	*Ground Stud	Card Cage
Q13578-01 -01 (marked for Side A)	P1	J1	Side A Overhead Antenna (HF)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (HF)
	P1	*J2A	Receive PCB
R20437-G01	J250	*P250	TI Gateway PCB T20128-G1
	J258A	P258	Side A CRIND Logic PCB T17764
	J258B	P258	Side B CRIND Logic PCB T17764
R20580-G1 (per unit)	3 prong F	3 prong M	Card Cage, Rear

Notes:

1. Asterisk (*) indicates connection point is on Card Cage assembly.
2. Route R20521-G1, R20521-G2, and R20437-G01 Cables through bottom of Card Cage to Side B for connections.
3. Check whether brand panel lighting ballast is connected to power supply. If so, disconnect ballast from power supply and terminate wires ends according to NFPA 70, the National Electric Code and applicable local codes.

Full System Cable Connections on MPD-3 Dispensers

For all single-sided units, install Dummy Load Connector (R20526-01) on JB on transmitter PCB and skip all Side B connections.

Note: If power is applied to Card Cage without the antenna cables or dummy load connected, the transmitter board will be damaged.

On Cable	Connect	To	On
R20509-G2 (marked for Side A)	P1/2	J1	Side A Overhead Antenna (low frequency)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked for Side B)	P1/2	J2	Side B Overhear Antenna (low frequency)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G3 (marked for Side A)	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Faceplate Assembly
	P7	*J7	DCB PCB Q13563
R20519-G3 (unmarked for Side B)	J182	P182	Light/Micro Reader PCB assembly T20182 on Side B Faceplate Assembly
	P8	*J8	DCB PCB Q13563
R20521-G3 (marked for Side A)	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Faceplate Assembly
	J177	*P177	Power Supply PCB T20138
	GRD	*Ground Stud	Card Cage
R20521-G3 (unmarked for Side B)	J180	P180	Light/Micro Reader Pcb Assembly T20182 on Side B Faceplate Assembly
	J176	*P176	Power Supply PCB T20138
	GRD	*Ground Stud	Card Cage
Q13578-01 -01 (marked for Side A)	P1	J1	Side A Overhead Antenna (high frequency)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (high frequency)
	P1	*J2A	Receive PCB
R20437-G01	J250	*P250	TI Gateway PCB T20128-G1
	J258A	P258	Side A CRIND Logic PCB T17764
	J258B	P258	Side BCRIND Logic PCB T17764
R20580-G1	P601		
	J601		
	3 prong F	3 prong M	Card Cage, Rear

*Indicates connection point is on Card Cage assembly.

Full System Cable Connections on The Advantage Series and MPD-3 Dispensers

For all single-sided units, install Dummy Load Connector (R20526-01) on JB on transmitter PCB and skip all Side B connections.

Note: If power is applied to Card Cage without antenna cables or dummy load connected, the transmitter board will be damaged.

On Cable	Connect	To	On
M00878A002	PA	JA	Transmitter PCB Q13579-01
	PB	JB	Transmitter PCB Q13579-01
	P1A	J1	Side A Low Frequency Overhead Antenna
	P1B	J1	Side B Low Frequency Overhead Antenna
	P2A	J2A	UHF Receive PCB Q13564
	P2B	J2B	UHF Receive PCB Q13564
	P3A	J2	Side A HF Overhead Antenna
	P3B	J2	Side B HF Overhead Antenna
R20509-G2 (marked for Side A)	P1/2	J1	Side A overhead antenna (low frequency)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked Side B)	P1/2	J2	Side B Overhead Antenna (low frequency)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G1	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	P7	*J7	DCB PCB Q13563
R20519-G2	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	P8	*J8	DCB PCB Q13563
R20521-G1	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	J177	*P177	Power supply PCB T20138
	GRD	*Ground Stud	Card Cage
R20521-G2	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	J176	*P176	Power Supply PCB T20138
	GRD	*Ground stud	Card Cage
Q13578-01 -01 (marked for Side A)	P1	J1	Side A Overhead Antenna (HF)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (HF)
	P1	*J2A	Receive PCB
R20437-G01	J250	*P250	TI Gateway PCB T20128-G1
	J258A	P258	Side A CRIND Logic PCB T17764
	J258B	P258	Side B CRIND Logic PCB T17764
R20580-G1 (per unit)	3 prong F	3 prong M	Card Cage, Rear

Notes:

1. *Indicates connection point is on Card Cage assembly.
2. Route R20521-G1, R20521-G2, and R20437-G01 Cables through bottom of Card Cage to Side B for connections.
3. Check whether brand panel lighting ballast is connected to power supply. If so, disconnect ballast from power supply and terminate wires ends according to NFPA 70, the National Electric Code and applicable local codes.

Hand-held System Cable Connections on The Advantage Series and MPD-3 Dispensers

For all single-sided units, install Dummy Load Connector (R20526-01) on JB on transmitter PCB and skip all Side B connections.

Note: If power is applied to Card Cage without antenna cables or dummy load connected, the transmitter board will be damaged.

On Cable	Connect	To	On
R20509-G2 (marked for Side A)	P1/2	J1	Side A Overhead Antenna (low frequency)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked for Side B)	P1/2	J2	Side B Overhead Antenna (low frequency)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G1	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	P7	*J7	DCB PCB Q13563
R20519-G2	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	P8	*J8	DCB PCB Q13563
R20521-G1	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	J177	*P177	Power Supply PCB T20138
	GRD	*Ground stud	Card Cage
R20521-G2	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	J176	*P176	Power Supply PCB T20138
	GRD	*Ground stud	Card Cage
Q13578-01 -01 (marked for Side A)	P1	J1	Side A Overhead Antenna (HF)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (HF)
	P1	*J2A	Receive PCB
R20437-G01	J250	*P250	TI Gateway PCB T20128-G1
	J258A	P258	Side A CRIND Logic PCB T17764
	J258B	P258	Side B CRIND Logic PCB T17764
R20580-G1 (per unit)	3 prong F	3 prong M	Card Cage, Rear

Notes:

1. *Indicates connection point is on Card Cage assembly.
2. Route R20521-G1, R20521-G2, and R20437-G01 Cables through bottom of Card Cage to Side B for connections.
3. Check whether brand panel lighting ballast is connected to power supply. If so, disconnect ballast from power supply and terminate wires ends according to NFPA 70, the National Electric Code and applicable local codes.

Full System Cable Connections on Encore 500 Dispensers

For all single-sided units, Dummy Load Connector (R20526-01) is installed on JB on transmitter PCB and eliminates all Side B connections.

Note: If power is applied to Card Cage without antenna cables or dummy load connected the transmitter board will be damaged.

On Cable	Connect	To	On
M00515A002	J3110	P3110	CRIND Control Node PCA M00089
	J250	P250	Gateway PCB T20678
M00878A001	PA	JA	Transmitter PCB Q13579-01
	PB	JB	Transmitter PCB Q13579-01
	P1A	J1	Side A Low Frequency Overhead Antenna
	P1B	J1	Side B Low Frequency Overhead Antenna
	P2A	J2A	UHF Receive PCB Q13564
	P2B	J2B	UHF Receive PCB Q13564
	P3A	J2	Side A High Frequency Overhead Antenna
	P3B	J2	Side B High Frequency Overhead Antenna
M00811A001	P1	J1	M00806A001 Power Distribution Cable
	3 Prong M	P3	3 Prong F, R20206 Power Input Cable
R20509-G2 (marked for Side A)	P1/2	J1	Side A Overhead Antenna (LF)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked for Side B)	P1/2	J2	Side B Overhead Antenna (LF)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G1	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	P7	*J7	DCB PCB Q13563
R20519-G2	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	P8	*J8	DCB PCB Q13563
R20521-G1	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	J177	*P177	Power supply PCB T20138
	GRD	*Ground stud	Card Cage
R20521-G2	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	J176	*P176	Power supply PCB T20138
	GRD	*Ground stud	Card Cage
Q13578 01-01 (marked for Side A)	P1	J1	Side A Overhead Antenna (HF)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (HF)
	P1	*J2A	Receive PCB
R20437-G01	J250	*P250	TI Gateway PCB T20128-G1
	J258A	P258	Side A CRIND Logic PCB T17764
	J258B	P258	Side B CRIND Logic PCB T17764
R20580-G1 (per unit)	3 prong F	3 prong M	Card Cage, Rear

Notes:

1. *Indicates connection point is on Card Cage assembly.
2. Route R20521-G1, R20521-G2, and R20437-G01 Cables through bottom of Card Cage to Side B for connections.
3. Check whether brand panel lighting ballast is connected to power supply. If so, disconnect ballast from power supply and terminate wires ends according to NFPA 70, the National Electric Code and applicable local codes.

Hand-held System Cable Connections on Encore 500 and Eclipse Dispensers

Following table lists the Hand-held System Cable Connections on Encore 500 and Eclipse Dispensers:

On Cable	Connect	To	On
M00515A002	J3110	P3110	CRIND Control Node PCA M00089
	J250	P250	Gateway PCB T20678
M00811A001	P1	J1	M00806A001 Power Distribution Cable
	3 Prong M	P3	3 Prong F, R20206 Power Input Cable
R20509-G2 (marked for Side A)	P1/2	J1	Side A Overhead Antenna (LF)
	PA/B	*JA	Transmitter PCB Q13564
R20509-G2 (unmarked for Side B)	P1/2	J2	Side B Overhead Antenna (LF)
	PA/B	*JB	Transmitter PCB Q13564
R20519-G1	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	P7	*J7	DCB PCB Q13563
R20519-G2	J182	P182	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	P8	*J8	DCB PCB Q13563
R20521-G1	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side A Options Door
	J177	*P177	Power supply PCB T20138
	GRD	*Ground stud	Card Cage
R20521-G2	J180	P180	Light/Micro Reader PCB Assembly T20182 on Side B Options Door
	J176	*P176	Power supply PCB T20138
	GRD	*Ground stud	Card Cage
Q13578-01-01 (marked for side A)	P1	J1	Side A Overhead Antenna (HF)
	P1	*J2B	Receive PCB
Q13578-01 (unmarked for Side B)	P1	J2	Side B Overhead Antenna (HF)
	P1	*J2A	Receive PCB

Notes:

1. *Indicates connection point is on Card Cage assembly.
2. Route R20521-G1, R20521-G2, and R20437-G01 Cables through bottom of Card Cage to Side B for connections.
3. Check whether brand panel lighting ballast is connected to power supply. If so, disconnect ballast from power supply and terminate wires ends according to NFPA 70, the National Electric Code and applicable local codes.

Antenna Cable Pin-to-Pin Connections (M00878A001 and M00878A002)

P1B To J1 Pin # on Side 1 Overhead LF Antenna	P1A To J1 Pin # on Side 2 Overhead LF Antenna	P3B To J2 Pin # on Side 1 Overhead HF Antenna	P3A To J2 Pin # on Side 2 Overhead HF Antenna	PB To JB for Side 1 Pin # on Q13579 Transmitter Board	PB To JB for Single-side Units Only With R20526-G1 Power Resistor	PA To JA for Side 2 Pin # on Q13579 Transmitter Board	P2A To J2A for Side A Pin # on Q13564 UHF Receive Board	P2B To J2B for Side B Pin # on Q13564 UHF Receive Board
1	1	1	1	1	N.C.	1	1	1
2	2	-	-	2	N.C.	2	-	-
-	-	-	-	3	-	3	-	-

Ribbon Cable Pin-to-Pin Connections (M00515A002)

J/PA To P250 Pin # On Gateway PCB (T20128)	To P3110 Pin # on CRIND Control Node (M00089)	Function
1	12	RX_A
2	13	GND_A
3	14	TX_A
4	11	+5V_A
5	-	SPARE_IN_A
6	-	N.C.
7	-	SPARE_OUT_A
8	5	RX_B
9	6	GND_B
10	-	TX_B
11	4	+5_B
12	-	SPARE_IN_B
13	-	N.C.
14	-	SPARE_OUT_B

Antenna Cable, Low Frequency Pin-to-Pin Connections (R20509-G1)

For single-sided units R20526 (see below) replaces R20509-G1 Cable used on Side B.

To JA/JB Pin # on Low Frequency Transmitter Board (Q13579)	To J1/J2 Pin # on Over Head Low Frequency Antenna
1	1
2	2
3*	unused

Note: *indicates to Ground.

Light/Micro Reader Cables Pin-to-Pin Connections (R20519-G1, R20519-G2, and R20519-G3)

To J7/J8 Pin # on Data Control Board (Q13563)	To P182 on Light/Micro Reader PCB (T20182)	Function
1	1	TX 232
2	2	GPO 232
3	3	AX 232
4	4	Light 232
5	5	RDEN
6	6	GND

R20521-G1 and R20521-G2 Interface Micro Reader Cables Pin-to-Pin Connections

To P176/P177 Pin # on Power Supply Board	To P180 Pin # on Light/Micro Reader PCB (T20182)	Function
1	1	+22v
2	2	+5v
3	3	GND

R20522-G1 Interface Hand-held Antenna Cable Pin-to-Pin Connections

To P190 Pin # on Hand-held Antenna T20143	To P181 Pin # on Light/Micro Reader PCB T20182
1	1
2	2

R20522-G2 Interface Hand-held Antenna Cable Pin-to-Pin Connections

To P190 Pin # on Hand-held Antenna T20524	To P181 Pin # on Light/Micro Reader PCB T20601
1	1
2	2

R20526 TI/RFID Dummy Load Transmitter Cable Pin-to-Pin Connections

Used for single-sided units in place of Side B R20509-G1 Cable to provide dummy load. If TRIND unit is powered without load on both Side A and B of Low Frequency Transmitter Board (Q13579) will be damaged.

R20526 Pin #	To JB Pin # on Low Frequency Transmitter Board (Q13579)
1	1
2	2
3	3

R20437-G01 TRIND to CRIND Logic Cable Pin-to-Pin Connections

Pin # on T20128 Gateway PCB	Pin # Side A P258 of CRIND Logic Board	Pin # on Side B P258 of CRIND Logic Board	Function
1	1	-	RX-A
2	2	-	GND-A
3	3	-	TX-A
4	4	-	+5V-A
5	5	-	Spare-In-A
6	6	-	N.C.
7	7	-	Spare-Out-A
8	-	1	RX-B
9	-	2	GND-B
10	-	3	TX-B
11	-	4	+5V-B
12	-	5	Spare-In-B
13	-	6	N.C.
14	-	7	Spare-Out-B

R20773-G2 Advantage Option TRIND Data and Power Cable Pin-to-Pin Connections

To Pin # on Side 1 and Side 2 Micro Reader PCB Plug P182 (M01218A001/A002)	To Pin # on TRIND Card Cage Harness Cable (T20662-G2) Plug P1 and P2	Function
1	1	TX
2	2	RX
3	3	GPO
4	4	GND
5	5	VCC
6	6	N.C.
7	7	-
8	8	ILLUM
9	9	GND
10	10	+22V
11	11	RDEN
12	12	N.C.

R20773-G2 Encore Option TRIND Data and Power Cable Pin-to-Pin Connections

To Pin # on Side A and Side B T20601 Light/Micro Reader PCB Plug P182		To Pin # on TRIND Card Cage Harness Cable (T20662-G2 Plug P1 and P2	Function
1		1	TX
2		2)	RX
3		3	GPO
4		4	GND
5		5	VCC
6		6	N.C.
7		7	-
8		8	ILLUM
9		9	GND
10		10	+22V
11		11	RDEN
12		12	N.C.

T20662-G2 TRIND Card Cage Cable Harness Cable Pin-to-Pin Connections

From P1 Pin # on T20662 TRIND Card Harness Cable	To J1/J2 Pin # on Side 1 R20773 TRIND Data and Power Cable	From P2 Pin # on T20662 TRIND Card Harness Cable	To J1/J2 Pin # on Side 2 R20773 TRIND Data and Power Cable	From P7 Pin # on T20662 TRIND Card Harness Cable	To J7 Pin # For Q13563 DCB	From P8 Pin # on T20662 TRIND Card Harness Cable	To J8 Pin # For Q13563 DCB	From J176 Pin # on T20662 Card Harness Cable	To P176 Pin # on Power Supply PCB	From J177 Pin # on T20662 Card Harness Cable	To P177 Pin # on Power Supply PCB
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	-	-	-	-
5	5	5	5	5	5	5	5	-	-	-	-
6	6	6	6	6	6	6	6	-	-	-	-
7	7	7	7	-	-	-	-	-	-	-	-
8	8	8	8	-	-	-	-	-	-	-	-
9	9	9	9	-	-	-	-	-	-	-	-
10	10	10	10	-	-	-	-	-	-	-	-
11	11	11	11	-	-	-	-	-	-	-	-
12	12	12	12	-	-	-	-	-	-	-	-

5 – System Accessories

ASC TRIND Tool Kit (K94577-01)

The ASC TRIND Tool Kit contains specialized tools required for installation and service of TRIND equipped units.

Kit Contents

The Tool Kit contains the following items.

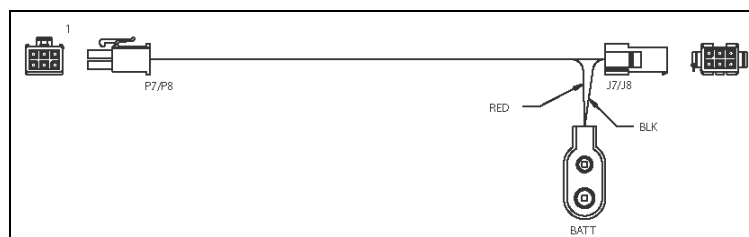
Description	Part Number	Quantity
Cable, Standalone Jumper	R20602-G1	1
Cable, Standalone Jumper	R20602-G2	1
Co-axial Cable Tool	Q13628-01	1
Field Strength Sensor Board	Q13626-01	1
Test Tag, TI/RFID Car Mount	Q13630-01	1
Test Tag, TI/RFID Hand-held	Q13630-02	1
Threaded Rod, 3/8-16 X 4"	N23880-01	4
Tuning Tool, Plastic Tipped	Q13631-01	1
Tuning Tool, Plastic Tipped	Q13631-02	1

Standalone Jumper Cables

Standalone Jumper Cable (R20602-G1) for LF/UHF Full System

This cable is used for MPD-3 installation or troubleshooting on any unit that requires placing the unit the standalone mode. After powering down unit, either Side A or B Light Micro Reader Cable (R20519-G3) is disconnected from either J8 (Side B) or J7 (Side A) on DCB in the TRIND Card Cage, and Standalone Jumper Cable is connected in-line (between J8 and P8 or between J7 and P7). A standard alkaline 9 V battery (not supplied with kit) must be connected to Standalone Jumper Cable.

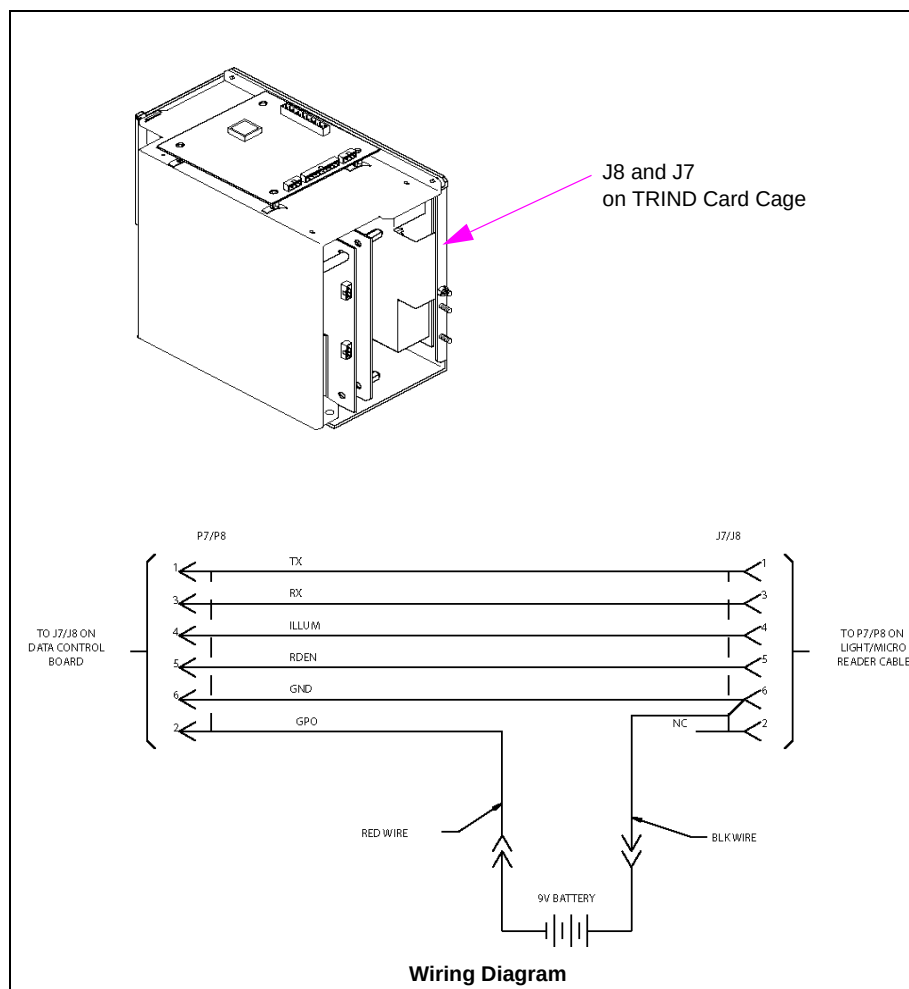
Figure 5-1: R20602-G1 Standalone Jumper Cable



Note: If Standalone Jumper or 9 V battery is not available, unit can be put in standalone using the jump jack on JP3.

Connector on R20602-G1	Connects To	On
J7/J8	Either J7 or J8	DCB PCB on Card Cage
P182	Either P7 or P8	Side A or B Light Micro Reader Cable (R20519-G3)
Battery connectors	Battery terminals	Standard 9 V alkaline battery

Figure 5-2: R20602-G1 Card Cage Connections and Wiring Diagram

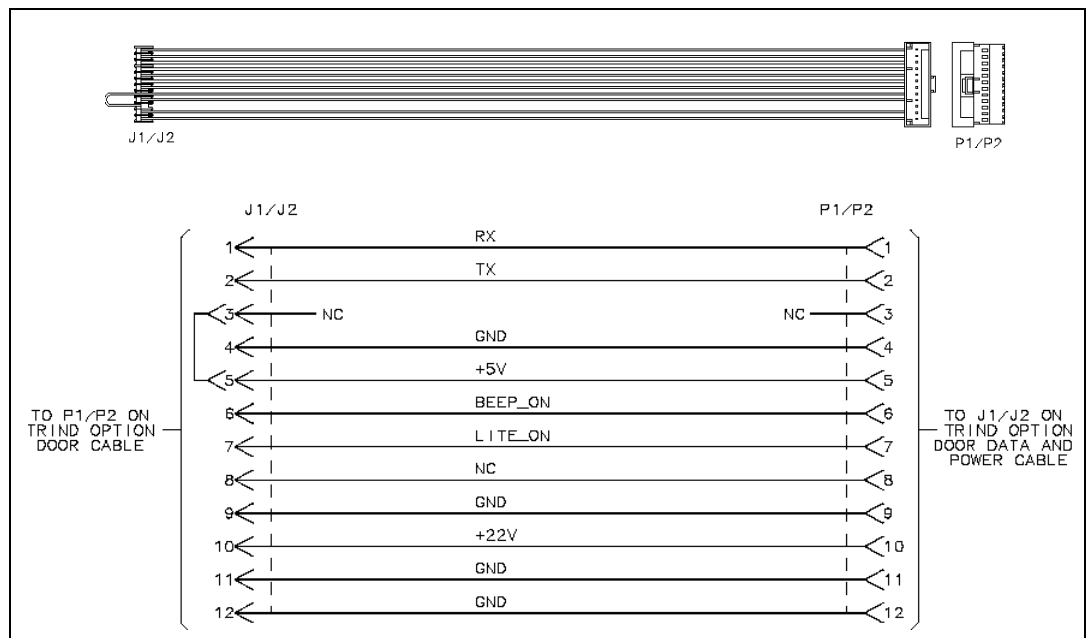


Standalone Jumper Cable (R20602-G2) for Enhanced Gateway

This cable is used for installation or troubleshooting, and for placing a unit in the “standalone” mode. The hand-held key tag units contain the T20606-G3 Card Cage Assembly and the Enhanced Gateway PCB (T20678-G1). After powering down unit, the P1 end of the M00507A001 Cable coming out of the Card Cage on Side A is disconnected. The P1/P2 end of the Standalone Jumper Cable is connected to the P1 end of the M00507A001 Cable, and the J1/J2 end of the Standalone Jumper Cable is connected to the J1/J2 end of the R20773-02 Cable that is connected to the Light Board Assembly (M01218A001). TRIND is in the “standalone” mode when power is restored to the unit.

Connector on R20602-G2	Connects To	On
P1/P2	P1	M00507A001 Cable (Side A)
J1/J2	J1/J2	R20773-G2 Cable

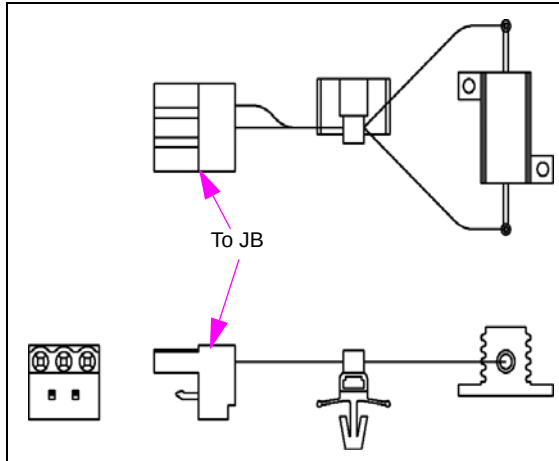
Figure 5-3: R20602-G2 Standalone Jumper Cable and Wiring Diagram



Dummy Load Transmitter (R20526)

Dummy Load Transmitter must be installed on JB of Transmitter PCB.

Figure 5-4: Dummy Load Transmitter

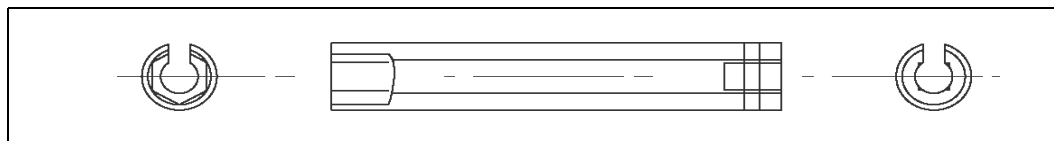


Co-axial Cable Tool (Q13628-01)

Co-axial Cable Tool is a hex-socket tool with a slit down its length. Co-axial cables are (M00878A001, M00878A002, and Q13578-01) are used for transmission from TRIND overhead antennas and come with hex connectors at either end. The Co-axial Cable Tool allows the installer to tighten cable connections in tight areas of the TRIND Card Cage and overhead connection box.

Note: Co-axial cable fits in to the slotted side of the Co-axial Cable Tool, allowing the socket to surround the hex-head of the cable connector. This allows connections to be made and tightened straight on, rather than from the side.

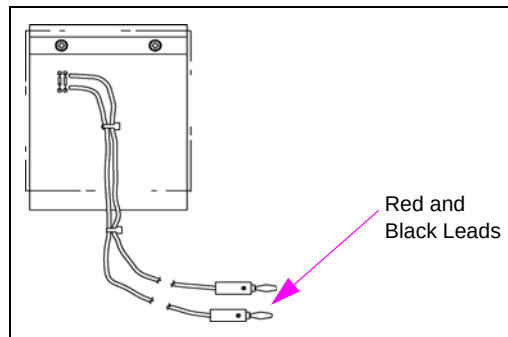
Figure 5-5: Co-axial Cable Tool



Field Strength Sensor Board (Q13626-01)

TRIND installation manuals and this document details the installation test for positioning of the Field Strength Sensor Board during antenna field tuning.

Figure 5-6: Field Strength Sensor Board

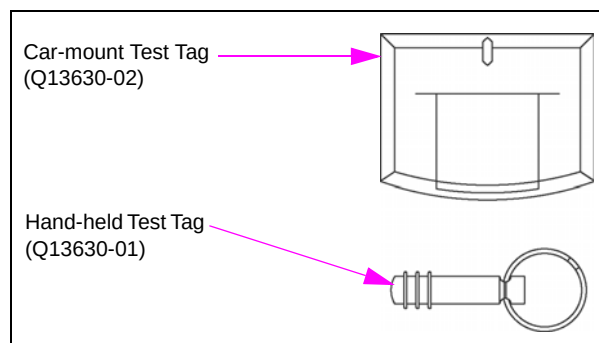


Set the multimeter to DC voltage. Connect the red and black leads of the standard multimeter to the field strength sensor board leads. As the antennas are tuned by incremental adjustments to the antenna's variable inductor (similar to a tuning pot), voltage reading increases or decreases. The field strength sensor board allows you to find the voltage peak, which is the tuning target.

Q13630-01 and Q13630-02 Test Tags

Hand-held Test Tag (Q13630-01) simulates a hand-held transponder and has the appearance of a key holder. Car-mount Test Tag (Q13630-02) simulates a customer's car mounted transponder. These tags are used to test operation of the TRIND system at installation.

Figure 5-7: Test Tags



Hand-held Test Tag

During testing, the Hand-held tag is placed against the TRIND target on either the right options door on The Advantage Series, or on the faceplate target located on the right side of MPD-3 bezel doors.

Note: Use of the test tags will cause a properly installed and operating TRIND system's target logo to light, indicating successful reading. An actual sale is not possible with these tags.

Car-mount Test Tag

Car-mount test tag is positioned properly when it is 6 feet from the overhead antennas and in a position that approximates that of a car's dashboard at the fuel island.

Note: The car tag has a replaceable battery that has a life of two to three years.

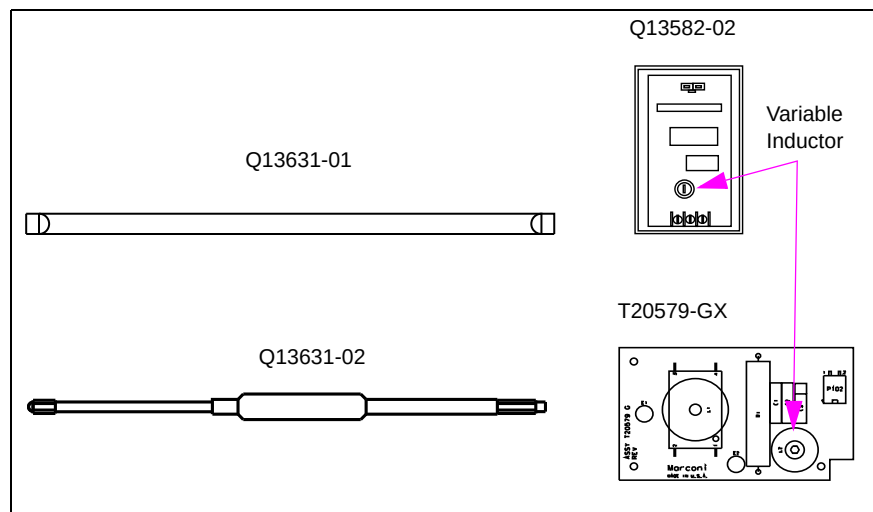
Tuning Tool (Q13631-01 and Q13631-02)

CAUTION

Only the Plastic Tuning Tool [Q13631-01 (or similar plastic 0.10-inch hex tool)], which is a part of ASC Tool Kit (K94577-01) must be used for tuning overhead antennas. Using a metal screwdriver or Allen wrench has two negative effects. First, proper tuning is impossible as the metal of the tool used changes the properties of the variable inductor used for tuning. Secondly, the ferrite slug used in the variable inductor is extremely brittle and is broken or stripped easily by metal tools, preventing the proper tuning of the antenna. If the antenna is not properly tuned, the read range can be significantly reduced.

In conjunction with Field Strength Sensor Board (Q13626-01), tuning tools are used to make variable inductor adjustments to tune the overhead antennas. The tools are plastic and non-reactive to the variable inductor or board on the overhead antennas, and should only be used to adjust variable inductor.

Figure 5-8: Tuning Tools



The Q13631-01 plastic flat-blade is used the same as a screwdriver. It is used with Q13582-02 and fits the slotted head of the variable inductor located on the overhead antenna PCB.

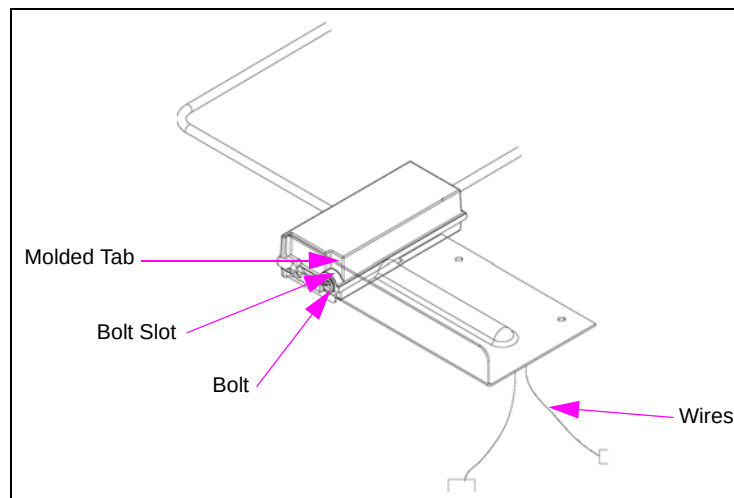
The Q13631-02 plastic blade is used the same as an Allen wrench. The wrench is used with Antenna Tuning Board (T20579-GX) and fits the Allen head of the variable inductor located on the Overhead Antenna PCB (T20579-GX, located in T20632-GX Assemblies).

6 – Procedures for Factory Installed TRIND

Positioning Overhead Antennas

TRIND overhead antennas are shipped mounted to the unit in the down position. [Figure 6-1](#) shows the TRIND antenna hardware and final antenna positioning on the unit.

Figure 6-1: Positioning TRIND Antenna



Perform the following procedures to position each overhead antenna:

Note: If installing the Mobil Display Cabinet (Blue Hat), leave the antennas in the down position until the display cabinet is installed. For display cabinet installation instructions, refer to “Dispenser Setup” on [page 7-1](#).

See [Figure 6-1](#) and perform the following steps to position the overhead antenna into its final position. Perform these steps for each side of the unit:

- 1 Loosen the bolts on the each side of the unit that secure the antenna boxes to the antenna brackets using a 3/8-inch nut driver.
- 2 Slide the antenna forward and away from the fueling unit in the bracket slots.
- 3 Rotate the antenna to the upright position parallel to the ground.

- 4 Slide the antenna back towards the unit until the bolts stop in the slots and the molded part of the antenna bracket is secure inside the bracket fork.

Note: Before tightening the bolts, ensure that the cables coming from the antenna are securely positioned inside the stamped groove part of the bracket and are not trapped under the bracket.

- 5 Tighten the bolts that secure the antenna into position using the 3/8-inch nut driver or equivalent.

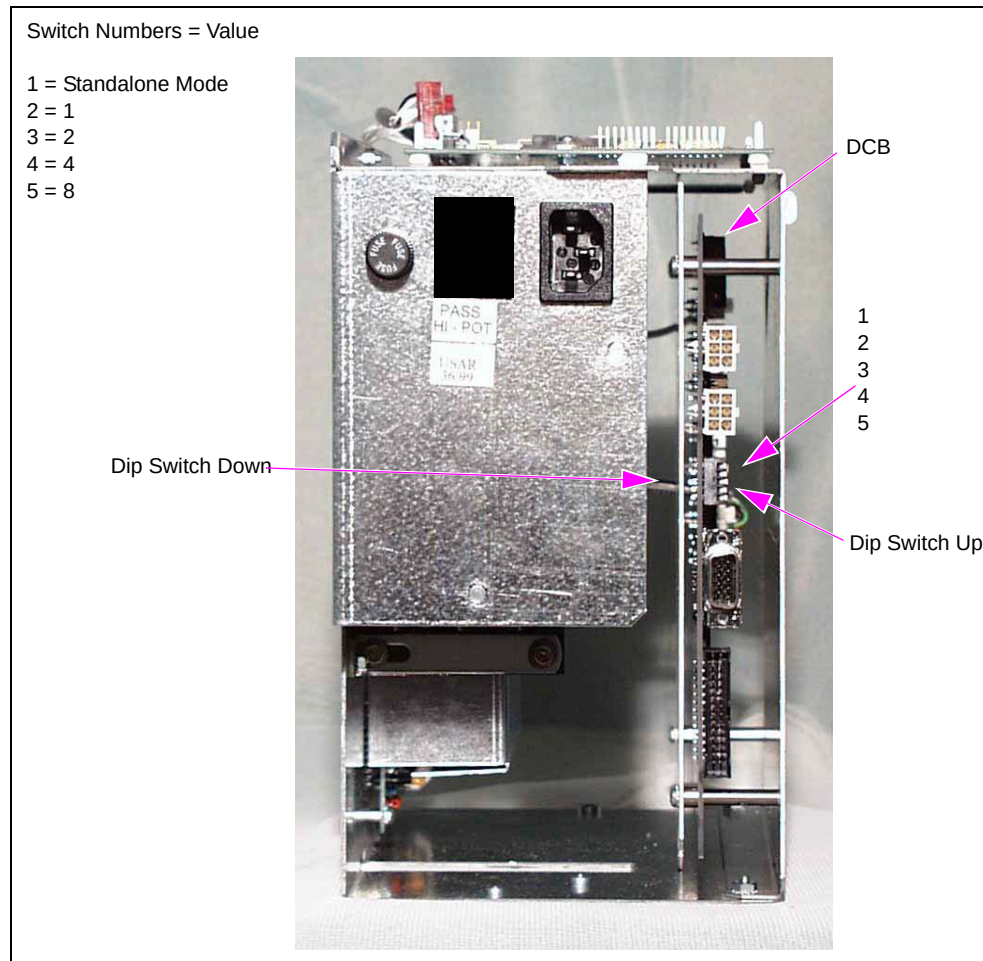
7 – Dispenser Setup

Addressing Dither Sync Address for LF/UHF Full System

Each dispenser on the G-SITE® system controller must be addressed differently; no two dispensers may have the same address. Addresses are at discretion of the installer.

Note: Before installing the Card Cage inside the dispenser, locate the dip switches on the DCB inside the Card Cage assembly (see [Figure 7-1](#)).

Figure 7-1: DCB and Dip Switch Location



- 1 From Side A of unit, locate the dip switches on the DCB inside the Card Cage.
- 2 Using switches 2, 3, 4, and 5, address each dispenser so that no two dispensers at one side are identical.

Setting Baud Rate

For Major Oil Company (MOC) TRIND installations, there is no requirement to set or change baud rate.

Addressing Gateway/Enhanced Gateway Board

Addresses for the TRIND device must match the addresses on CRIND Logic Board.

- 1 Access the unit's CRIND Logic Board. Refer to *MDE-2562 CRIND Service Manual*.
- 2 Locate jump jacks on A and B side CRIND Logic Boards [T17764-XX (see [Figure 7-3](#) on [page 7-3](#))].
- 3 Note position of jump jacks and set jump jacks on Gateway/Enhanced Gateway Board (see [Figure 7-2](#)) to match address on CRIND Logic Boards (see [Figure 7-3](#) on [page 7-3](#)) for both Sides A and B.

Note: The Gateway Boards are assessable at the upper left hand corner at the front of the Card Cage.

Figure 7-2: Gateway Boards Jump Jack Locations

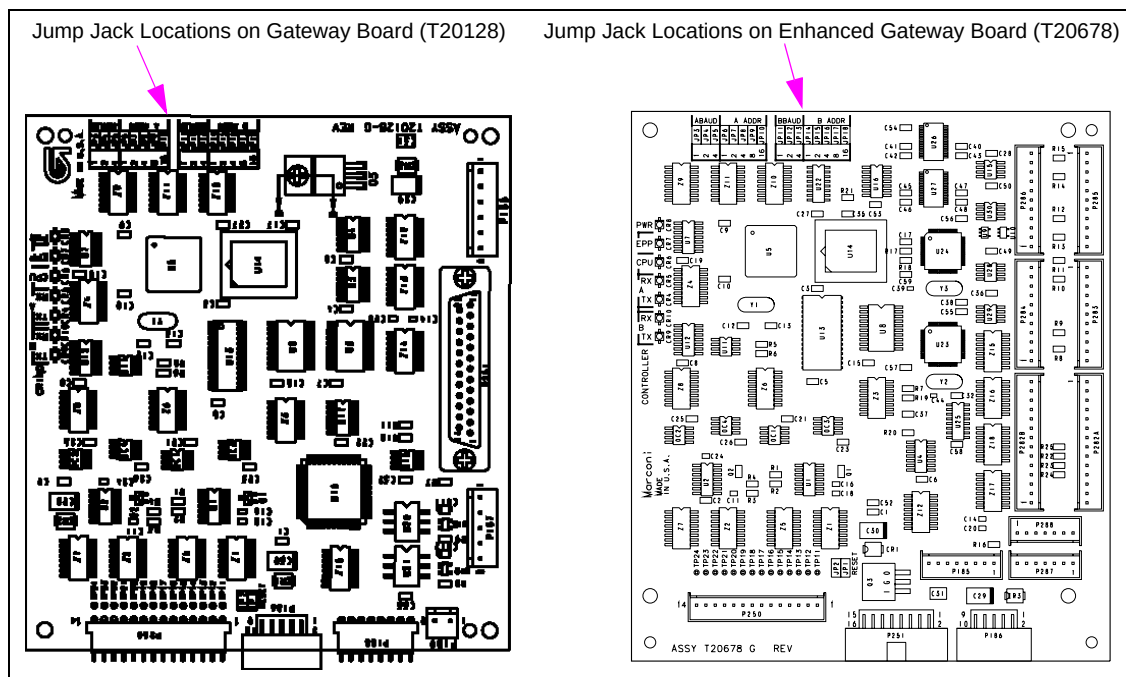
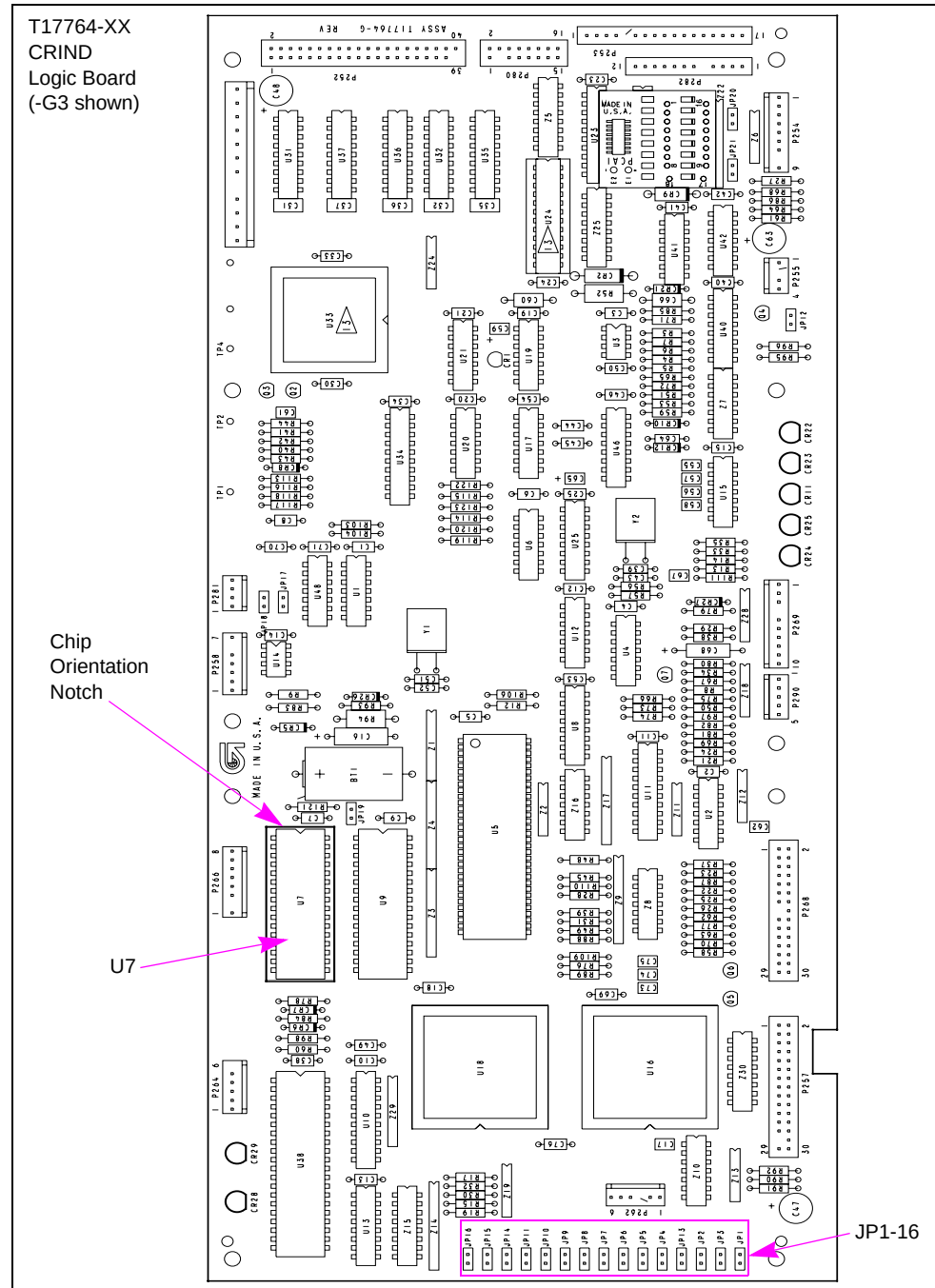


Figure 7-3: CRIND Logic Board (T17764-XX)



CRIND Address Table

Following table provides a cross-reference between addresses on the T17764 CRIND Logic Board and the Gateway Boards.

MOC and Generic CRIND Addresses					
Address On CRIND Logic Board T17764-XX	JP8	JP7	JP6	JP5	JP4
= Address on Gateway Board 'A' Side	JP6	JP7	JP8	JP9	JP10
= Address on Gateway Board 'B' Side	JP14	JP15	JP16	JP17	JP18
1	IN	OUT	OUT	OUT	OUT
2	OUT	IN	OUT	OUT	OUT
3	IN	IN	OUT	OUT	OUT
4	OUT	OUT	IN	OUT	OUT
5	IN	OUT	IN	OUT	OUT
6	OUT	IN	IN	OUT	OUT
7	IN	IN	IN	OUT	OUT
8	OUT	OUT	OUT	IN	OUT
9	IN	OUT	OUT	IN	OUT
10	OUT	IN	OUT	IN	OUT
11	IN	IN	OUT	IN	OUT
12	OUT	OUT	IN	IN	OUT
13	IN	OUT	IN	IN	OUT
14	OUT	IN	IN	IN	OUT
15	IN	IN	IN	IN	OUT
16	OUT	OUT	OUT	OUT	IN
17	IN	OUT	OUT	OUT	IN
18	OUT	IN	OUT	OUT	IN
19	IN	IN	OUT	OUT	IN
20	OUT	OUT	IN	OUT	IN
21	IN	OUT	IN	OUT	IN
22	OUT	IN	IN	OUT	IN
23	IN	IN	IN	OUT	IN
24	OUT	OUT	OUT	IN	IN
25	IN	OUT	OUT	IN	IN
26	OUT	IN	OUT	IN	IN
27	IN	IN	OUT	IN	IN
28	OUT	OUT	IN	IN	IN
29	IN	OUT	IN	IN	IN
30	OUT	IN	IN	IN	IN
31	IN	IN	IN	IN	IN
32	OUT	OUT	OUT	OUT	OUT

Preparation for Tuning Antennas

Antenna tuning requires use of Field Strength Sensor Board supplied with the ASC TRIND Tool Kit. For information on using Field Strength Sensor Board, refer to “[Field Strength Sensor Board \(Q13626-01\)](#)” on [page 5-5](#).

- 1 For units without G-SITE, put unit in ‘standalone’ mode. Refer to “[Standalone Jumper Cable \(R20602-G1\) for LF/UHF Full System](#)” on [page 5-1](#) and “[Standalone Jumper Cable \(R20602-G2\) for Enhanced Gateway](#)” on [page 5-3](#).
- 2 Restore power to unit(s).
- 3 After restoring power to the unit, verify that the unit is in “standalone” mode by observing that the LEDs on the light board are flashing.

Tuning Antennas

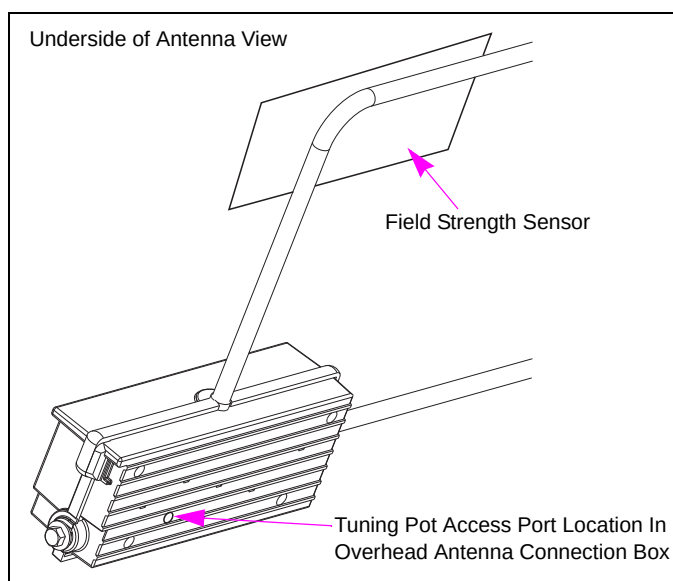
Following sections provide instructions on tuning the Single-loop and Mobil antennas.

Tuning Single-loop Antennas

Perform the following steps in to tune a Single-loop Antenna.

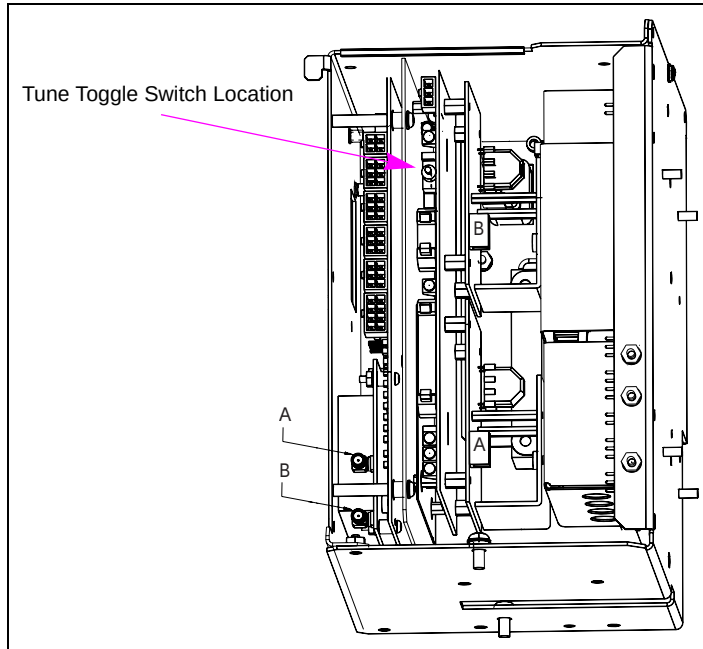
- 1 Locate the access port for the tuning pot in the overhead antenna connection box on Side A.
Note: Use Tuning Tool (Q13631-XX) from the ASC TRIND Tool Kit to make pot adjustments. For instructions, refer to MDE-3640 ASC TRIND Tool Kit. Hex end of tuning tool matches hex shape of tuning pot.
- 2 Lay field strength sensor on the antenna as shown in [Figure 7-4](#). Exact location is not critical.

Figure 7-4: Field Strength Sensor Positioning



- 3 On the Card Cage, move the three position “tune” toggle switch (see [Figure 7-5](#)) from center position to “A”.

Figure 7-5: Tuning Toggle Switch Locations



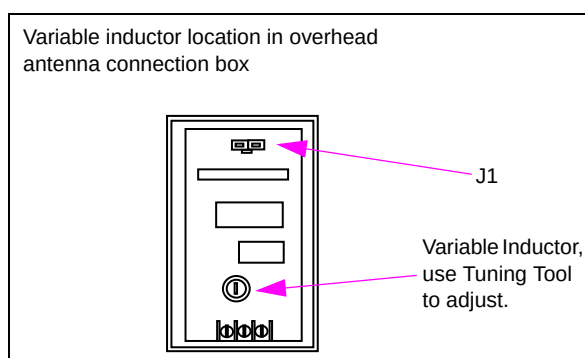
- 4 Connect the leads to field strength sensor. Position the multimeter selector switch to DC voltage.
- 5 By fine adjustments to tuning pot, set to highest DC voltage reading.
- 6 Voltage will peak at a point, and then decrease with turns in either direction. Set at peak.
- 7 Repeat steps 1 on [page 7-5](#) through 5 for position “B” and then return tune toggle switch to center position.

Mobil Antennas

To tune a Mobil Antenna, proceed as follows:

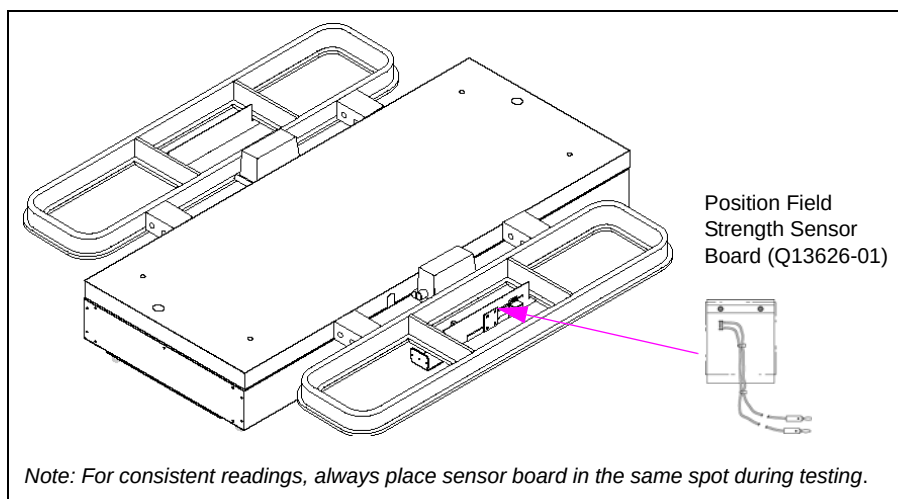
- 1 Locate variable inductor on PCB in the over-head antenna connection box. The variable inductor, similar to a tuning pot, has a slot for the tuning tool. For more information on Mobil Antennas, refer to “[Mobil Overhead Antenna Assembly \(T20231\)](#)” on [page 4-14](#).
- 2 The variable inductor on the Side A overhead antenna connection box should be turned out five to six turns as a starting point.
Note: Use tuning tool from the ASC TRIND Tool Kit to make adjustments.

Figure 7-6: Variable Inductor Location



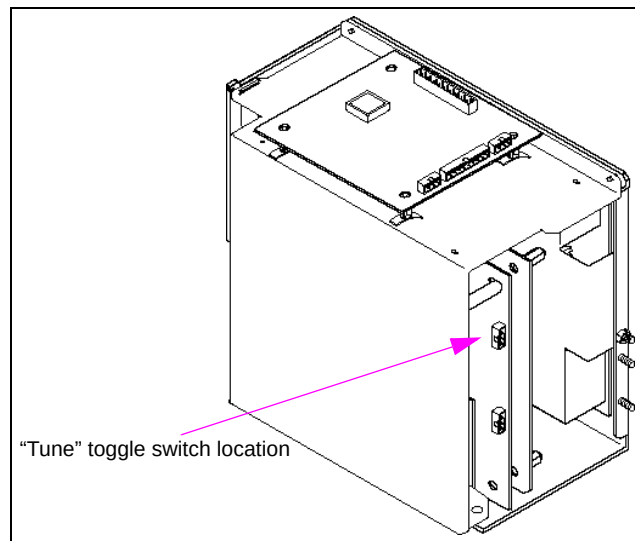
- 3 Lay field strength sensor flat at a position (see [Figure 7-7](#)) on the Side A plastic antenna housing, to the right of connection box.

Figure 7-7: Field Strength Sensor Location on Side A



- 4 On Card Cage, move the three position “tune” toggle switch from the center position to “A”.

Figure 7-8: Tune Toggle Switch Location



- 5 Connect the leads on the multimeter to field strength sensor. Set the meter to the DC voltage range.
- 6 By fine adjustments to variable inductor, set to the highest DC voltage reading.
Note: Voltage will peak at a point between 12 VDC and 20 VDC, and then decrease with turns in either direction. Set at peak.
- 7 Repeat steps 1 on [page 7-7](#) through 6 for Side B.
- 8 When finished, return the tune toggle switch to the center position.

8 – Testing and Troubleshooting

Following sections provide testing and troubleshooting information for the TRIND system. The status indicator section describes the characteristics of key TRIND indicators when the TRIND system is operating properly. The troubleshooting flow chart section provides a graphical guide to assist in troubleshooting the TRIND system.

Note: The majority of failures that occur are attributed to insufficient initial setup detail. Proper Gateway Board addressing and accurate cable connections are crucial to the effective operation of the TRIND system.

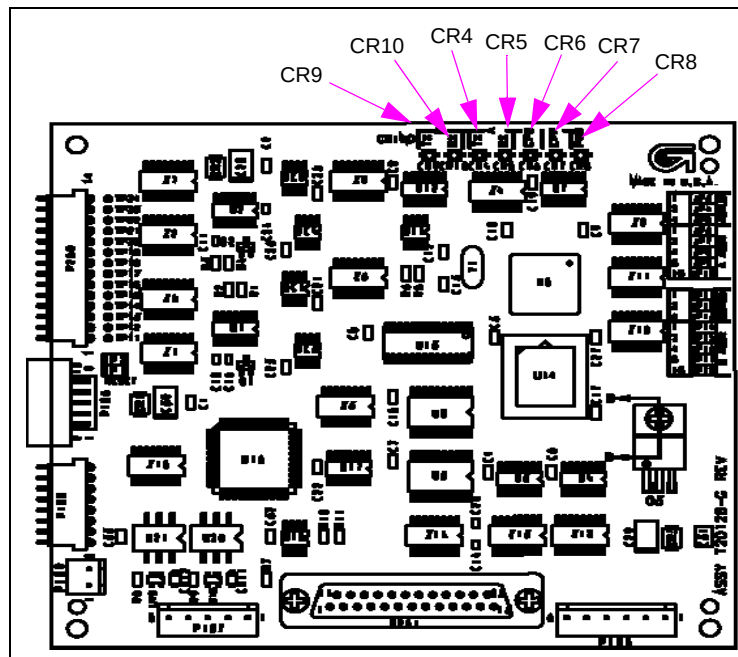
Status Indicators

Following sections describe the display characteristics of key indicators when the TRIND system is functioning properly.

Gateway Board (T20128)

Figure 8-1 shows Status indicators for the Gateway Board.

Figure 8-1: Gateway Board



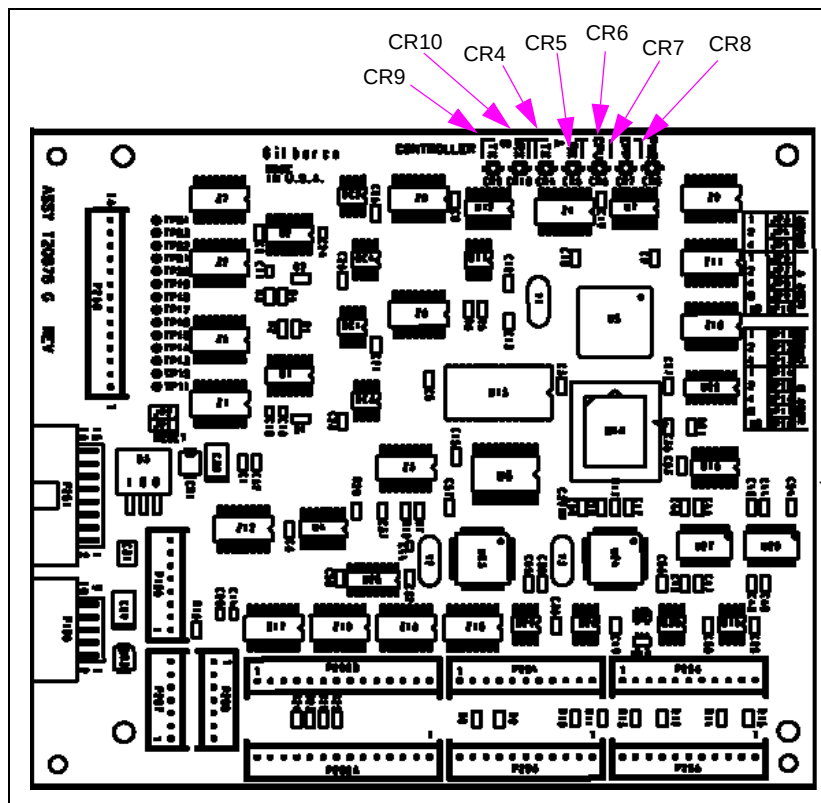
The Gateway Board will have the following indicator characteristics when operating properly:

- +5 VDC LED on solid (CR8).
- Blinking Central Processing Unit (CPU) LED (CR6). A dimly lit LED can also indicate proper operation because the blink rate becomes so fast that the LED appears dimmer than the +5 VDC LED (CR8).
- Rapidly Blinking CRIND A and B LEDs. Side A is CR4 (TX), CR5 (RX), Side B is CR9 (TX). These LEDs indicate good communication with the CRIND. They mimic the LEDs on the series of T17764 CRIND Boards. The Encore 500 Series CRIND node has two TRIND LEDs, D12 and D13, present in board under the TRIND connector.

Enhanced Gateway Board (T20678)

Figure 8-2 shows Status indicators for the Enhanced Gateway Board.

Figure 8-2: Enhanced Gateway Board



Enhanced Gateway Board will have the following indicator characteristics when operating properly:

- +5 VDC LED on solid (CR8).
- Blinking CPU LED (CR6). A dimly lit LED can also indicate proper operation because the blink rate becomes so fast that the LED appears dimmer than the +5 VDC LED (CR8).
- Rapidly Blinking CRIND A and B LEDs. Side A is CR4 (TX), CR5 (RX), Side B is CR9 (TX). These LEDs indicate good communication with the CRIND. They mimic the LEDs on the T17764 series of CRIND Boards. The Encore 500 Series CRIND node has two TRIND LEDs, D12 and D13, present in board under the TRIND connector.

Data Control Board (Q13563)

Status indicators for the Q13563-01 DCB are shown in [Figure 8-3](#) and the status indicators for the Q13563-04 DCB are shown in [Figure 8-4](#) on [page 8-4](#).

Figure 8-3: Q13563-01 DCB Indicators

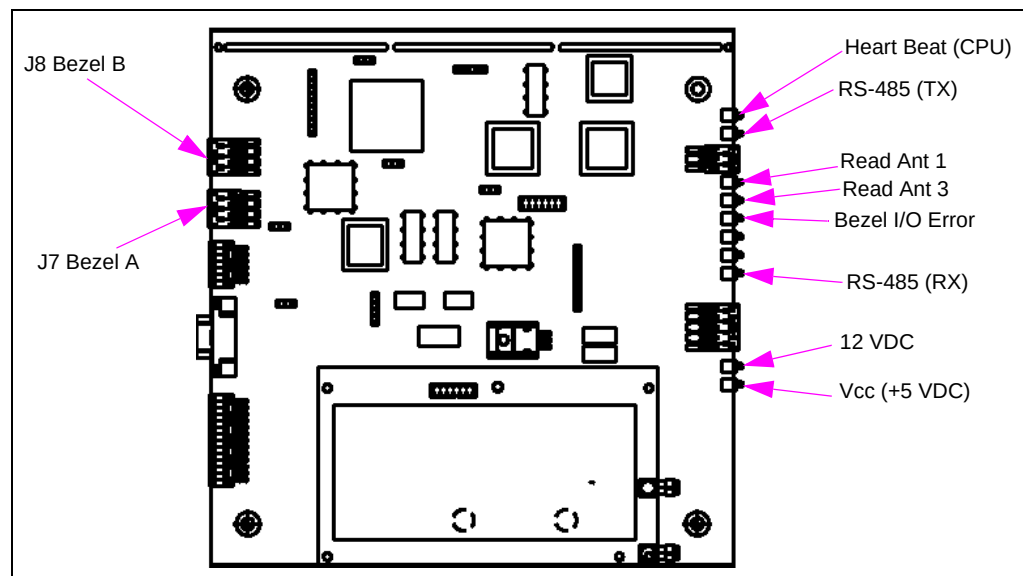
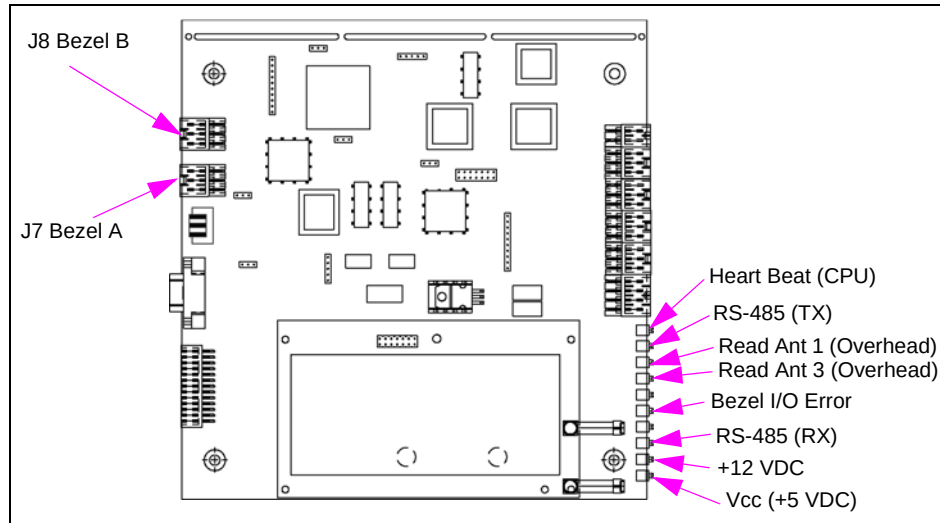


Figure 8-4: Q13563-04 DCB Indicators



The Q13563 DCB will have the following indicator characteristics when operating properly:

- VCC and +12 VDC LEDs on solid (D14 and D13, respectively).
- Heartbeat LED (CPU) blinking (D9).
- RS-485 LED's strobbing rapidly (D2 and D3).

Note: One may watch the communications begin between the Gateway Board and the DCB with these LEDs. The first several sequences are the waking up of the DCB and then commands sent down. This LED activity looks spurious. After a few rounds of that behavior, the RS-485 LEDs will begin firing at a regular pace, indicating that a link has been established. The RS-485 LEDs fire at a regular pace only when the Gateway Board is looking for tags. When the CRIND does not want the Gateway to look for tags (or has never initiated communication with the Gateway), the RS-485 LEDs fire once every 10 seconds after any initial wakeup.

- When a car tag has been presented, the READ ANT 1 (D8) or READ ANT 3 (D7) LED will light, depending upon the side.
- If the Bezel Input Output (I/O) error LED (D6) is on, then one of the Light/Micro Reader Boards is not connected or has lost communication.

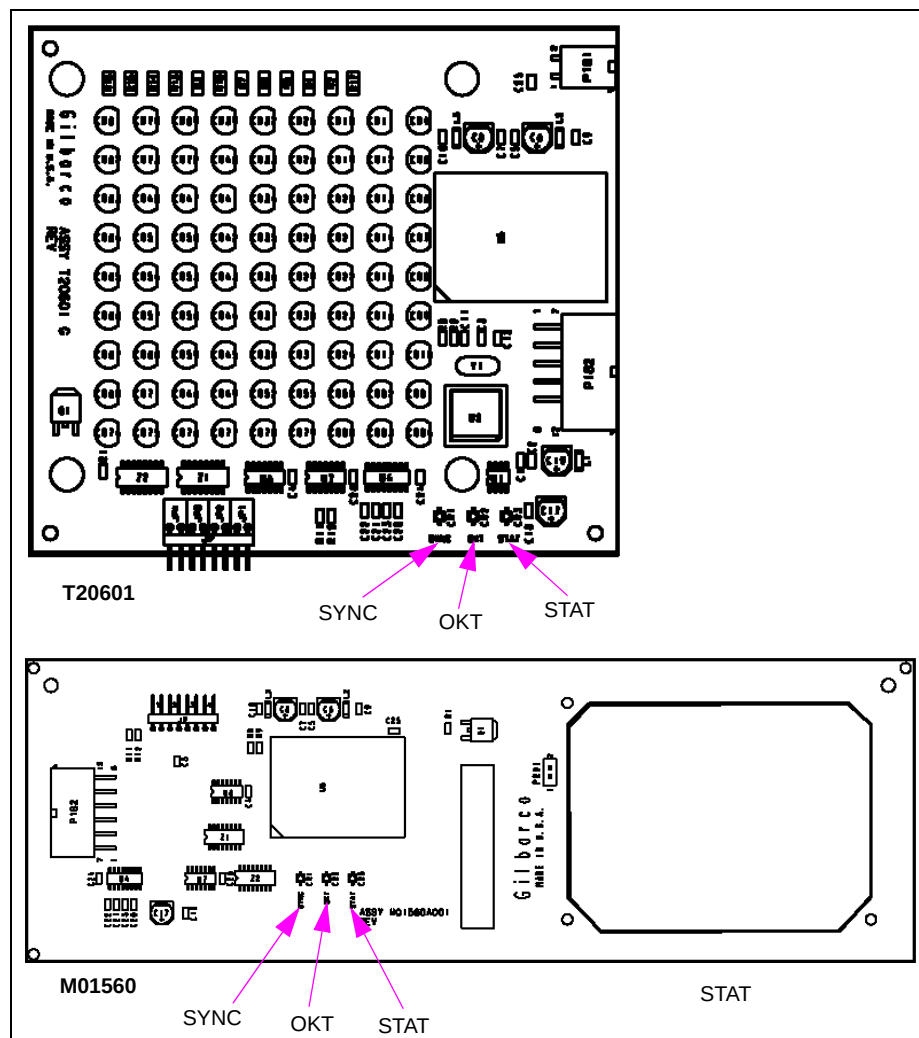
T20601/M01560 Light/Micro Reader Boards

The Light/Micro Reader Boards (see [Figure 8-5](#)) will exhibit the following characteristic when operating properly:

Note: The M01560 is a subassembly of Light and Inductor PCB Assembly (M01218).

- SYNC LED blinking (CR1).
- OKT LED on solid (CR2) until a tag is presented, then it will flicker while a key tag is in the field.
- STAT LED (CR3) blinking in unison with the SYNC LED.
- If these LEDs are solid, then the TRIND has not been told to look for tags, and consequently will never light the LEDs on the Light/Micro Reader Board.

Figure 8-5: RFID Light/Micro Reader Boards



Isolating TRIND from CRIND

To isolate the TRIND system from CRIND, proceed as follows:

- 1 Shut off all power to unit.
- 2 Disconnect either Side A or B Light Micro Reader Cable (R20519-G3) from either J8 (Side B) or J7 (Side A) on the DCB in the TRIND Card Cage, and insert the standalone jumper in-line (between J8 and P8 or between J7 and P7). For jumper details, refer to [“Standalone Jumper Cable \(R20602-G1\) for LF/UHF Full System”](#) on page 5-1.

Note: If Standalone Jumper Cable (R20602-G1) or 9 V alkaline battery is not available, unit can be put in standalone mode by installing jump jack on JP3 on Light/Micro Reader Board (for information on Isolating TRIND from CRIND, refer to [“Light/Micro Reader PCB \(T20446-G1, T20601-GX, M01580A001, and M01580A002\)”](#) on page 4-31). Perform for Side A only for the Card Cage Assembly.

- 3 Remove J4 from DCB.
- 4 Restore power to unit, and test TRIND operation (for information on test TRIND operation, refer to [“Dummy Load Transmitter \(R20526\)”](#) on page 5-4. If TRIND functions properly the problem is with CRIND or CRIND related equipment, refer to *MDE-2562 CRIND Service Manual*.

Tag Testing

Perform the following procedures to begin TRIND tag testing. To test the full controller drive capability, do not place TRIND in the standalone mode. Allow the dispenser network to detect the other subsystems (pump, CRIND, TRIND, etc.). The standalone procedure will verify that TRIND hardware is good (or not). The standalone procedure isolates TRIND from CRIND.

Car Mounted Test Tags

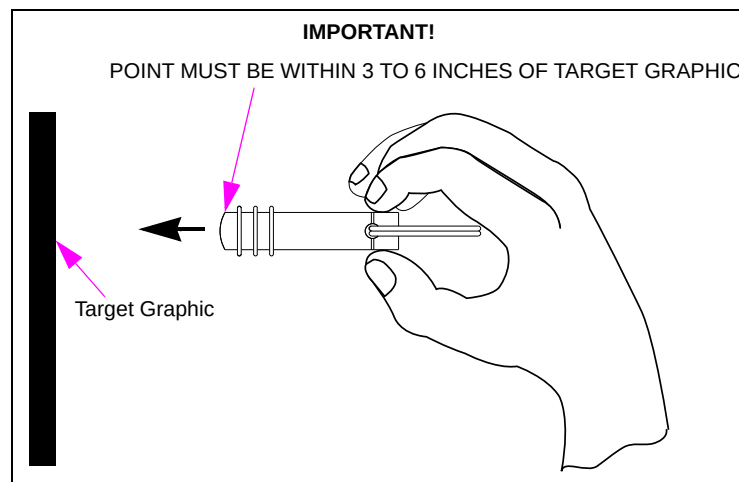
- 1 Place the unit into the standalone mode. For the appropriate standalone cable connection, refer to [“Standalone Jumper Cable \(R20602-G1\) for LF/UHF Full System”](#) on page 5-1.
- 2 From Side A of the unit, hold the Car Mount Test Tag, from the ASC TRIND Tool Kit in front of the unit at a distance of approximately 6 inches from the face of unit. Observe that the door or faceplate TRIND indicator lights.
- 3 Repeat steps 1 and 2 for Side B.

Hand-held Test Tags

To test the Hand-held Tags, proceed as follows:

- 1 Place the unit into the standalone mode. For the appropriate standalone cable connection, refer to [“Standalone Jumper Cable \(R20602-G2\) for Enhanced Gateway”](#) on [page 5-3](#).
- 2 From Side A of the unit, point the Hand-held Test Tag, from the ASC TRIND Tool Kit at the TRIND target graphic (see [Figure 8-6](#)). The TRIND indicator lights when the tag is approximately 3 inches or less away from the target graphic. Repeat for Side B.
Note: If the indicator fails to light, check whether the light on the other side is on; if so, it indicates a crossing of Side A and B cables. Check the connections.

Figure 8-6: Positioning TRIND Hand-held Test Tag



- 3 Repeat steps [1](#) and [2](#) for Side B.

Alternative Testing Using Laptop

To implement the TRIND testing using the Laptop Tool, proceed as follows:

- 1 Connect laptop to RS-232 port on DCB.
Note: The directory paths shown in steps 2 through 4, are representative of a directory structure that may be found on a laptop or personal computer. Some directory paths may differ depending upon the computers software setup and hardware configuration.
- 2 Go to:
“C:\windows program(hyperterminal)\Accessories\Terminal\Settings\Communications”
- 3 Set for:
 - 9600 baud
 - 8 bit
 - No parity
 - Comm 1
- 4 Then go to:
 - Help screen\Antenna scan
 - Next, at “Antenna scan”, select 1, 2, 3, and 4.*Note: This tests both antennas.*
- 5 From Side A of unit, position the Hand-held Test Tag, from the ASC TRIND Tool Kit in front of the TRIND target graphic. Observe that the door or faceplate TRIND indicator glows.
- 6 From Side A of unit, hold the Car Mount Test Tag from the ASC TRIND Tool Kit in front of unit, at a distance of approximately 6 feet from overhead antenna. Observe that the door or faceplate TRIND indicator glows.
- 7 Repeat steps 5 and 6 for Side B.

Troubleshooting T20229-G1 PCB on Card Cage Assembly

Following tables provide indications and steps to verify board operation and troubleshoot problems.

Light/Micro Reader Board (T20295-G1)

Light/Micro-reader PCA LEDs provide the best starting point for TRIND troubleshooting (see following table), whether TRIND is in standalone mode or connected to CRIND and G-SITE.

The Light/Micro Reader PCA performs two functions:

- Provides the customer with an indication of authorization to begin fueling.
- Communicates hand-held tag information to DCB board.

Connection	Function
P180	Receives +5 V, +22 V and GRD from TI/RFID Power Supply.
P181	Hand-held tag information is passed to Micro Reader mounted on Light/Micro Reader. Micro Reader processed information is passed to DCB for further processing through CRIND to MOC authorization network.
P182	When authorization is given DCB signals Light/Micro Reader Board to light LEDs through this connection.

LED	Function	Indication
CR1	SYNC	CR1 and CR3 indicate communications with DCB: • Pulsing in sync operation is normal. • Solid on, power is present but communication is not. Check whether both Side A and B Boards give same indication. If both sides are on solid on, check Gateway and DCB LEDs as detailed in previous sections. • If LEDs are out, 5 V power is lost. Check connections to TI/RFID Power Supply and voltages.
CR3	STAT	
CR2	OKT	Normal operation will be solid until hand-held tag is presented, at which point it will begin to faintly flicker. This is observable in daylight, but best observed in low-light situations.

Gateway PCB (T20128-G1)

Normal Operation	Abnormal Operation/Failure	Cause/Action Required
PWR LED (CR8) constant on; indicates 5 V supplied	No LED activity.	Check TI/RFID Power Supply PCB for 5 V output.
CPU LED (CR6) continuous rapid pulse. Blinking CPU LED (CR6). A dimly lit LED can also indicate proper operation because the blink rate has become so fast that the LED appears dimmer than the +5 VDC LED (CR8).	No LED activity (indicates software not running).	Do the following: • CRIND reset of Gateway may be stalled. Power TRIND down and up and verify whether problem is corrected. • If not, replace Gateway PCB.
TX (CR4, CR9) and RX (CR5, CR10) at power up display asynchronous activity (date transfer between Gateway and CRIND), followed by synchronous activity. TX LEDs indicate data to CRIND; RX LEDs data from CRIND.	Either or both RX LEDs on steady.	If there is serial connection between CRIND and Gateway is suspect, do the following: • P250 on Gateway PCB. • P258 on CRIND Logic Board. • R20437-G01 Cable
	Either or both RX LEDs blinking and TX LEDs off indicates Gateway not responding to CRIND poll.	Do the following: • Check address jump jack settings on CRIND and Gateway boards for identical settings (A=A; B=B). • If address jump jack settings are correct, replace Gateway PCB.

Transmitter PCB (Q13579-01)

If tags are not being read, Transmitter PCB may be the cause. To verify that transmitter is functioning, perform steps in [“Tuning Antennas”](#) on [page 7-5](#).

Normal Operation	Abnormal Operation/Failure	Cause/Action Required
3 LEDs (one green, two yellow) lit. (If ambient noise conditions allow, can also hear repetitive clicks of transmitter switchers firing). • LED 1 (green) indicates 5 V supplied. • LED 2 (yellow) indicates Side A side switch power @ 18 V. • LED 5 (yellow) indicates Side B switcher power @ 18 V.	LED 1 is out or dim.	Do the following: • Check for +5 V power supply at J6 (pin 1 = +22 V; pin 2 = +5 V; pin 3 = GND). • If voltage low or non-existent, unplug J6, cycle power on TRIND and recheck voltage with J6 unplugged. • If voltage is present and correct, replace Transmitter PCB.
	LED 2 or 5 out (only one).	Side A or B module failure. Replace Transmitter PCB.

DCB (Q13563-01)

Normal Operation	Abnormal Operation/Failure	Cause/Action Required
• LED CR2 (+5 V) on solid.	CR10 and CR11 not pulsing.	Check RS-485 serial connection (J4)*.
• LED CR3 (+12 V) on solid.	CR7 lit (Bezel I/O error).	Will only light when a Light/Micro Reader PCB has a communication problem.
• CR10 (RS-485 RX) and CR11 (RS-485 TX) pulsing synchronously.		
• CR5 (heartbeat) pulsing.	CR2/CR3 not lit.	Check TI/RFID Power Supply Board.
• CR6 (Read ANT) will light when tag is read.	CR6 not lighting.	Refer to "Tuning Tool (Q13631-01 and Q13631-02)" on page 5-6.
	CR5 not pulsing.	Replace DCB.

*This is serial connection for DCB and Gateway Boards and means by which TRIND talks to G-SITE POS system.

TI/RFID Power Supply (T20138-G1)

Power supply is gated, a current sensing circuit will turn off the “power rail” if a harmful situation is detected. A problem on another board will cause a shut-off of power output from the TI/RFID Power Supply PCB.

To troubleshoot TI/RFID Power Supply:

- 1 Verify the voltage output from TI/RFID (refer to [“T20138 and T20314 Power Supply Boards”](#) on page 4-6).
Note: Voltages are bussed, meaning that output can be checked at a single point on the board.
- 2 If voltage not present or reduced, verify that TI/RFID Power Supply is receiving 60 V from Transformer at P174.
- 3 If 60 V is present, power down TRIND, remove connector at P173, power up, and recheck voltage with connector still off.
- 4 If voltage is normal, problem is on DCB (see following table). If problem persists, reconnect P173, and repeat step 3 for each of the following in sequence (except P173) or until problem board is located:

Connector	Problem Identified (if voltage returns to normal)
P173	DCB
P175	DCB
P176	Light/Micro Reader PCB Side B
P177	Light/Micro Reader PCB Side A
P178	Transmitter PCB
P179	Gateway PCB

Troubleshooting Flowcharts for T20606 Card Cage System

Following flowcharts are used to assist in troubleshooting TRIND Systems. Use these flowcharts as an aid in performing maintenance on TRIND devices.

Figure 8-7: TRIND Troubleshooting Flowchart (Sheet 1 of 4)

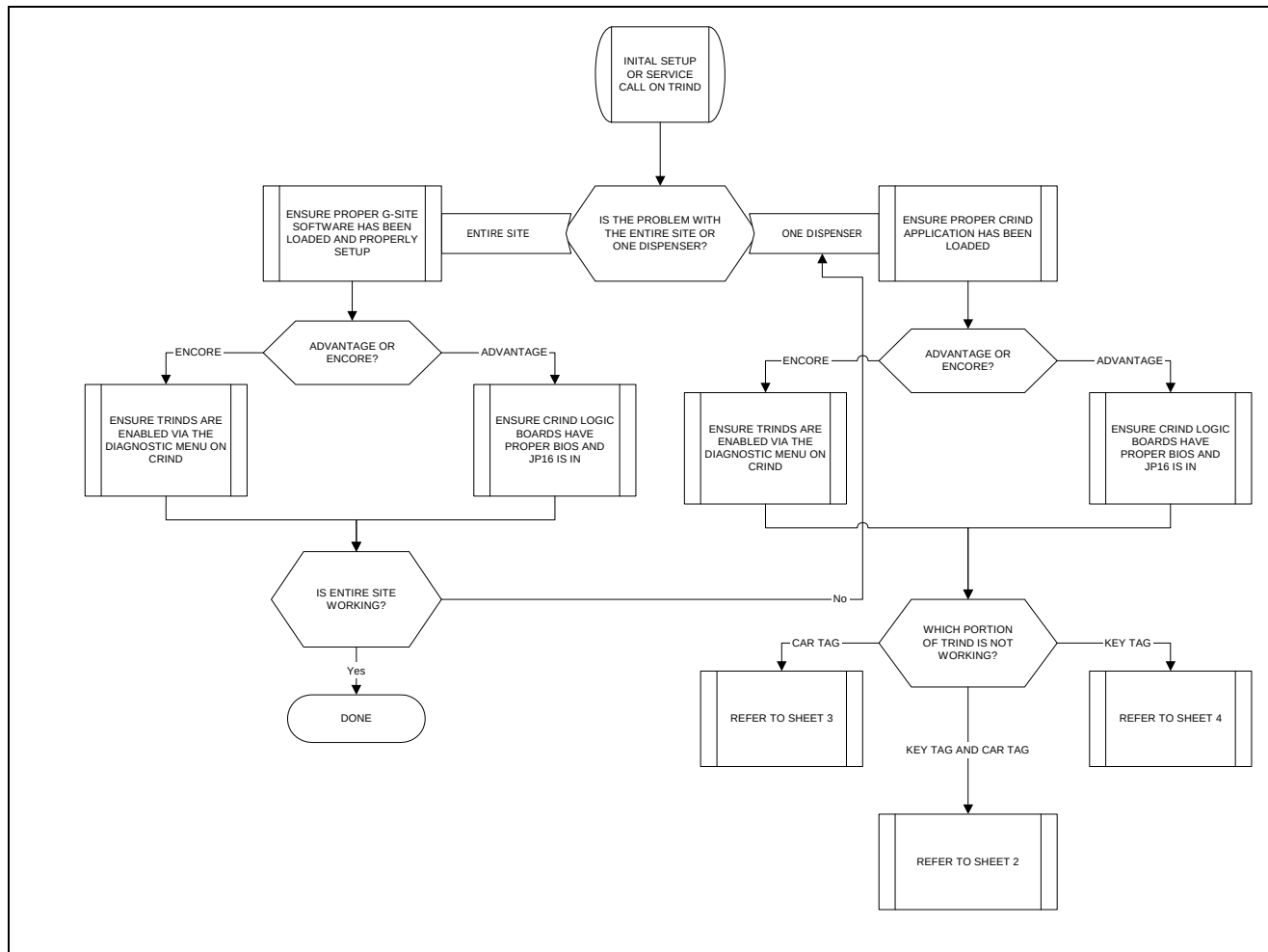


Figure 8-8: TRIND Troubleshooting Flowchart (Sheet 2 of 4)

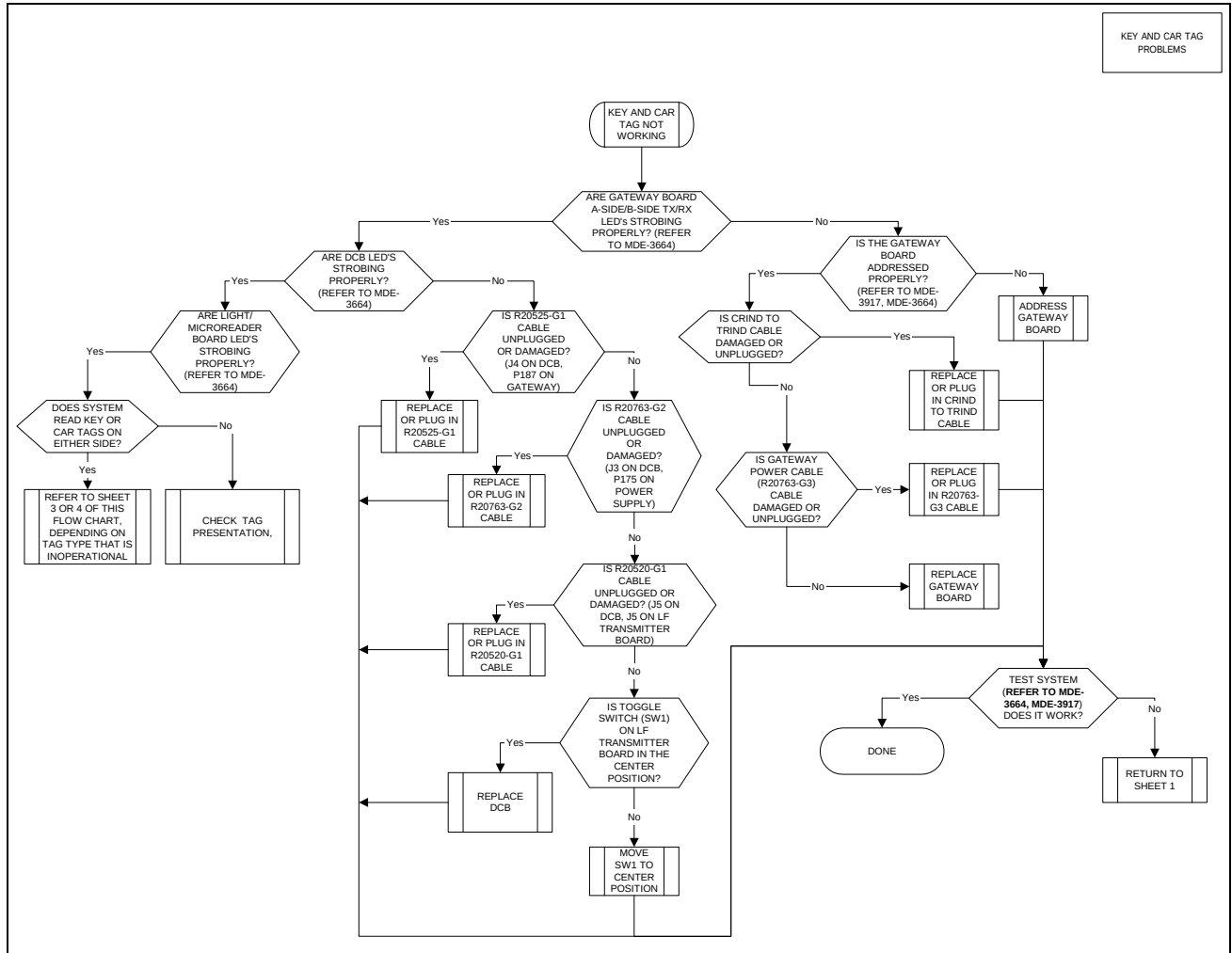


Figure 8-9: TRIND Troubleshooting Flowchart (Sheet 3 of 4)

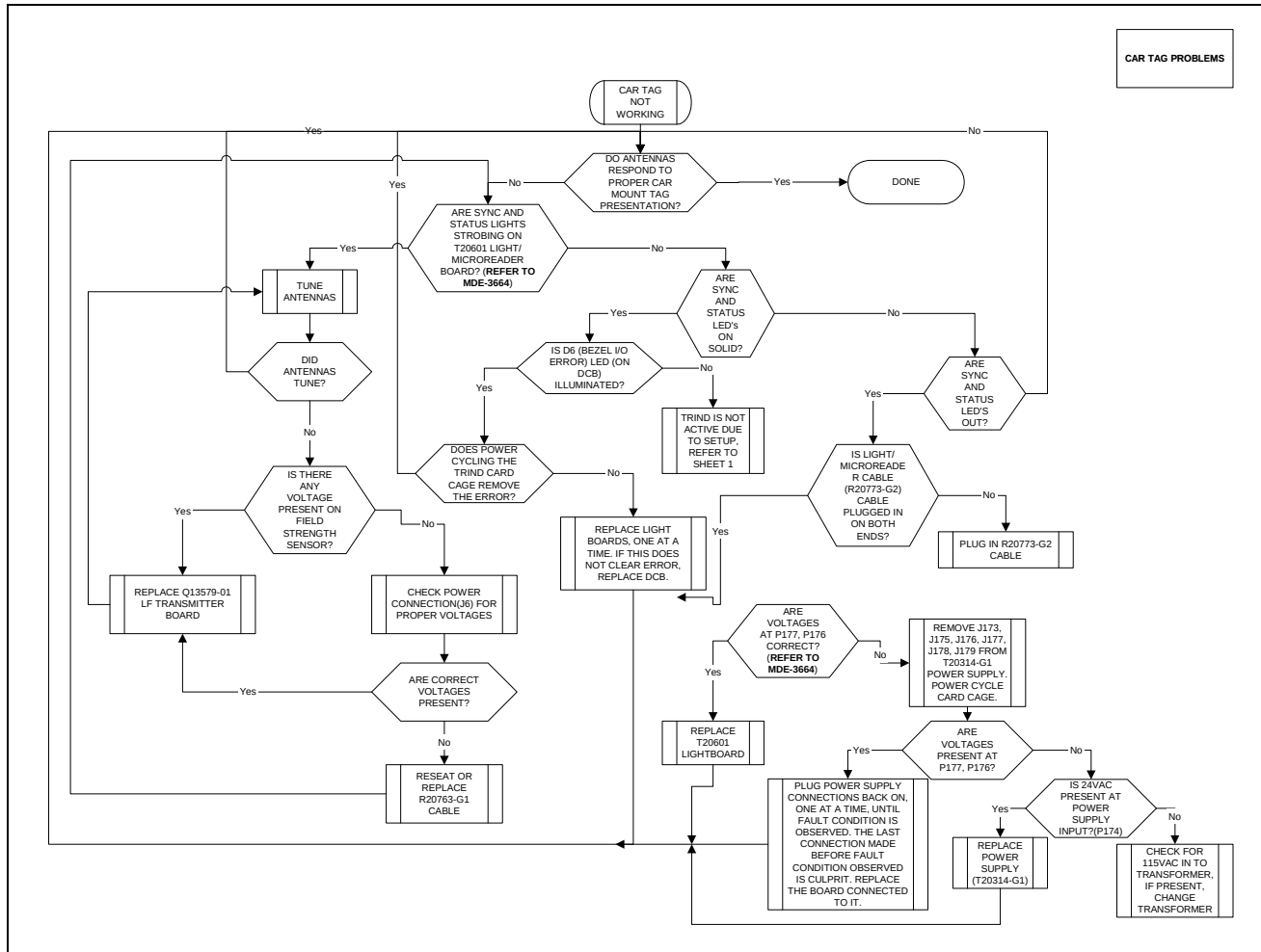
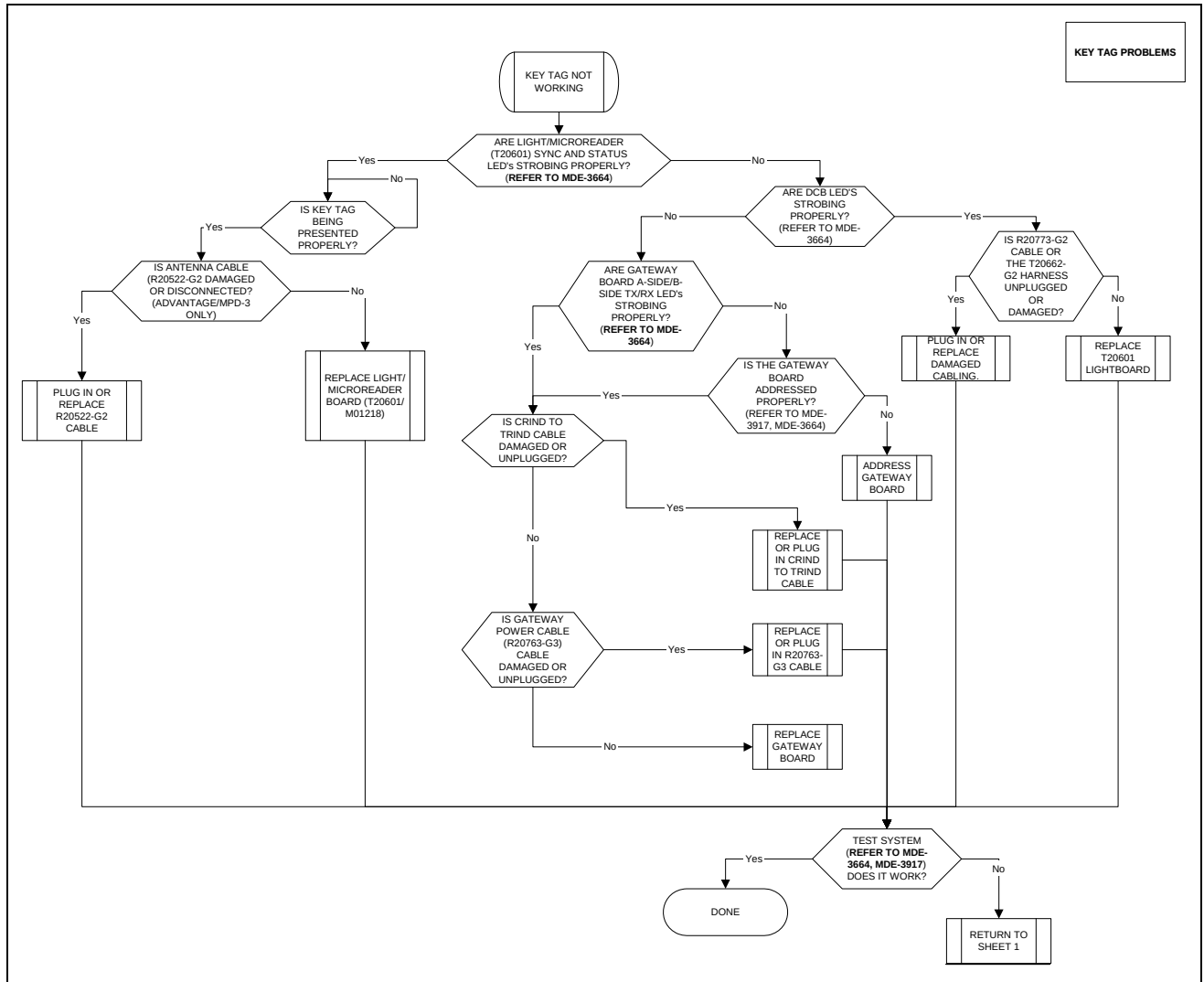


Figure 8-10: TRIND Troubleshooting Flowchart (Sheet 4 of 4)



Field Problem Survey

In the event of a problem requiring technical support from Gilbarco, make a copy of this form, gather the following survey information before calling (1-800-743-7501), and fax the form to 336-547-5359. This will facilitate delivery of the assistance you need. Do not write on this form. Make copies to ensure that a clean copy is available for future field problem surveys.

ASC Name	Company	Number
Station Name	POC	Number

* G-SITE/CRIND Information C2_____ PC_____ InfoScreen®_____ Monochrome_____ Single-line_____

of Dispensers at site _____

of Dispensers with problem _____

Detailed description of problem(s)/symptom(s): _____

Problem Dispenser _____

* Gateway Board LEDs On Off Pulsing

'A' TX & RX			
'B' TX & RX			
CPU			
PWR			
EPP			

* Data Control Board LEDs On Off Pulsing

'Heartbeat' CR5			
RS-485 TX CR11			
RS-485 RX CR10			
VCC CR2			
12V CR3			

* Light/Micro Reader Board LEDs A on A off A Pulsing B on B off B pulsing

Stat						
Okt						
Sync						

Address of CRIND Logic Boards A _____ B _____

Address of Gateway Board A _____ B _____

Address of TRIND Regulator (Old System) JP4(8)_____ JP3(4)_____ JP2(2)_____ JP1(1)_____

Dip Switches (New System) JP2(1)_____ JP3(2)_____ JP4(4)_____ JP5(8)_____

CRIND Boards -G and Revision Level _____

Gateway Board -G and Revision Level _____

* Check one

9 – Glossary

A

Alignment - The orientation of the tag to the reader in pitch, roll, and yaw.

Antenna - Any structure or device used to collect or radiate electromagnetic waves.

C

Car Key Tag - The transmitter/receiver pair or transceiver plus the information storage mechanism attached to the object is referred to as the tag, transponder, electronic label, code plate and various other terms.

D

Dipole Antenna - Usually a straight, center-fed, one-half wavelength antenna.

DIP Switch - A group of subminiature switches mounted in a package compatible with standard integrated-circuit sockets.

E

Electromagnetic Wave - Wave that is propagated by the mutual interaction of electric and magnetic fields. Radiant heat, light and radio waves are electromagnetic waves.

EMI - Electromagnetic Interference - unwanted signals that interfere with the equipment or system that is in use.

ETSI - European Telecommunications Standards Institute.

G

Gate - In analog circuitry, an electronic switch which is held open by a control signal.

H

HF - High Frequency - portion of the electromagnetic spectrum from 3MHz to 30MHz.

I

Inductive Coupling - Systems that use the inducing of a current in a coil as a means of transferring data or power are said to use inductive coupling.

L

LED - Light Emitting Diode

LF - Low Frequency - portion of the frequency spectrum from 30kHz to 300kHz.

M

Magnetic Field - Field of Force to which magnetic materials and permanent or electromagnets respond. Surrounds any magnet or electric current. May be most easily visualized as the force exerted by the field on a tiny magnet placed in the path of a radio wave or moved about within the field of another magnet.

Modulation - The methods of modulating or altering the carriers in order to carry the encoded information are quite varied. They include Amplitude Modulation (AM)/ phase modulation (PM), frequency modulation (FM), Frequency Shift Keyed (FSK), pulse position (PPM), pulse duration (PDM) and continuous wave (CW). In some cases, different modulating techniques are used in each direction (to and from the tags).

N

Noise - Unwanted, usually random, electrical or electromagnetic energy that interferes with the detection of wanted signals.

O

Orientation - Alignment of the tag with respect to the scanner, measured in pitch, roll, and yaw.

P

Passive Tags - Passive tags contain no internal power source. They are externally powered and typically derive their power from the carrier signal radiated from the scanner.

R

Resonance - The condition in a circuit containing inductance and capacitance in which the inductive reactance is equal and opposite to the capacitive reactance. ($X_L = X_C$) This condition occurs at only one frequency and the circuit in that condition is said to be in resonance or at the natural frequency.

RFID - Radio Frequency Identification Systems that read or write data to RF tags that are present in a radio frequency field projected from RF reading/writing equipment. Data may be contained in one (1) or more bits for the purpose of providing identification and other information relevant to the object to which the tag is attached. It incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the spectrum to communicate to or from a tag through a variety of modulation and encoding schemes.

S

SMA - Sub Miniature A.

Speedpass - An RFID system used for wireless payment in ExxonMobil branded fuel dispensers. This system has been available as a payment option since 1997 at Mobil branded stations and since 2001 at Exxon branded stores (www.speedpass.com).

T

TIRIS - Texas Instruments Registration and Identification Systems - This is the group name of the fine folks at Texas Instruments that produce and market RFID products, including two boards in the vehicle-mounted/key-tag Speedpass system. This group is now known as TI*RFID Systems (www.tiris.com).

TRIND - Transmitter/Receiver in Dispenser - This is Gilbarco Inc. trademarked name for the product also known as Speedpass.

Tuned Circuit - The selection of a desired signal and the rejection of all other (unwanted) signals by a circuit. When a circuit is 'tuned', it is operating at one frequency and rejecting all others.

Tuning - Adjusting the parameters and components of a circuit so that it resonates at a particular frequency or so that the current or voltage is either maximized or minimized at a specific point in the circuit. Note: Tuning is usually accomplished by adjusting the capacitance or the inductance, or both, of elements that are connected to or in the circuit.

U

UHF - Ultra-Hi Frequency - portion of the frequency spectrum from 300MHz to 3GHz.

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Appendix A - Radio Frequency Identification Defined

Overview

IMPORTANT INFORMATION

The information in this appendix was obtained from Association for Automatic Identification and Mobility (AIM).

A basic RFID system consists of three components:

1. An antenna or coil.
2. A transmitter/receiver.
3. A tag that is electronically programmed with unique information.

The antenna emits radio signals to activate the tag and read and write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system's data acquisition and communication. Antennas are available in a variety of shapes and sizes; they can be built into a door frame to receive tag data from persons or things passing through the door, or mounted on an interstate toll booth to monitor traffic passing by on a freeway. The electromagnetic field produced by an antenna can be constantly present when multiple tags are expected continually. If constant interrogation is not required, a sensor device can activate the field.

Often the antenna is packaged with the transceiver and decoder to become a reader (a.k.a. interrogator), which can be configured either as a handheld or a fixed-mount device. The reader emits radio waves in ranges of anywhere from 1 inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

RFID tags come in a wide variety of shapes and sizes. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and one-half inch in length. Tags can be screw-shaped to identify trees or wooden items, or credit card shaped for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are RFID tags. In addition, heavy-duty 5X4X2-inch rectangular transponder used to track intermodal containers or heavy machinery, trucks, and railroad cars for maintenance and tracking applications are RFID tags.

RFID tags are categorized as either active or passive. Active RFID tags are powered by an internal battery and are typically read/write, i.e., tag data can be rewritten and/or modified. An active tag's memory size varies according to application requirements; some systems operate with up to 1 MB of memory. In a typical read/write RFID work-in-process system, a tag might give a machine a set of instructions, and the machine would then report its performance to the tag. This encoded data would then become part of the tagged part's history. The battery supplied power of an active tag generally gives it a longer read range. The trade off is greater size, greater cost, and a limited operational life (which may yield a maximum of 10 years, depending upon operating temperatures and battery type).

Passive RFID tags operate without a separate external power source and obtain operating power generated from the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade off is that they have shorter read ranges than active tags and require a higher-powered reader. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Read-only tags most often operate as a license plate into a database, in the same way as linear barcodes reference a database containing modifiable product-specific information.

RFID systems are also distinguished by their frequency ranges. Low-frequency (30 kHz to 500 kHz) systems have short reading ranges and lower system costs. They are most commonly used in security access, asset tracking, and animal identification applications. HF (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) systems, offering long read ranges (greater than 90 feet) and high reading speeds, are used for such applications as railroad car tracking and automated toll collection. However, the higher performance of HF RFID systems incurs higher system costs.

The significant advantage of all types of RFID systems is the noncontact, non-line-of-sight nature of the technology. Tags can be read through a variety of substances such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging conditions, where barcodes or other optically read technologies would be useless. RFID tags can also be read in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. The read/write capability of an active RFID system is also a significant advantage in interactive applications such as work-in-process or maintenance tracking. Though it is a costlier technology (compared with barcode), RFID has become indispensable for a wide range of automated data collection and identification applications that would not be possible otherwise.

What is RFID?

The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by machine-readable means, at a suitable time and place to satisfy particular application needs. Data within a tag may provide identification for an item in manufacture, goods in transit, a location, and the identity of a vehicle, an animal or individual. By including additional data the prospect is provided for supporting applications through item specific information or instructions immediately available on reading the tag. For example, the color of paint for a car body entering a paint spray area on the production line, the set-up instructions for a flexible manufacturing cell or the manifest to accompany a shipment of goods.

A system requires, in addition to tags, a means of reading or interrogating the tags and some means of communicating the data to a host computer or information management system. A system will also include a facility for entering or programming data into the tags, if this is not undertaken at source by the manufacturer. Quite often an antenna is distinguished as if it were a separate part of an RFID system. While its importance justifies the attention it must be seen as a feature that is present in both readers and tags, essential for the communication between the two.

To understand and appreciate the capabilities of RFID systems it is required to consider their constituent parts. It is also required to consider the data flow requirements that influence the choice of systems and the practicalities of communicating across the air interface. By considering the system components and their function within the data flow chain it is possible to grasp most of the important issues that influence the effective application of RFID. However, it is useful to begin by briefly considering the manner in which wireless communication is achieved, as the techniques involved have an important bearing upon the design of the system components.

Wireless Communication and Air Interface

Communication of data between tags and readers is accomplished using wireless communication. Two methods distinguish and categorize RFID systems, one based upon close proximity electromagnetic or inductive coupling and one based upon propagating electromagnetic waves. Coupling is via “antenna” structures forming an integral feature in both tags and readers. While the term antenna is generally considered more appropriate for propagating systems, it is also loosely applied to inductive systems.

Transmitting data is subject to the vagaries and influences of the media or channels through which the data has to pass, including the air interface. Noise, interference and distortion are the sources of data corruption that arise in practical communication channels that must be guarded against in seeking to achieve error free data recovery. Moreover, the nature of the data communication processes, being asynchronous or unsynchronized in nature, requires attention to the form in which the data is communicated. Structuring the bit stream to accommodate these needs is often referred to as channel encoding and although transparent to the user of an RFID system the coding scheme applied appears in system specifications. Various encoding schemes can be distinguished, each exhibiting different performance features.

To transfer data efficiently via the air interface or space that separates the two communicating components requires the data to be superimposed upon a rhythmically varying (sinusoidal) field or carrier wave. This process of superimposition is referred to as modulation, and various schemes are available for this purposes, each having particular attributes that favor their use. They are essentially based upon changing the value of one of the primary features of an alternating sinusoidal source, its amplitude, frequency or phase in accordance with the data carrying bit stream. On this basis one can distinguish Amplitude Shift Keying (ASK), FSK, and Phase Shift Keying (PSK).

In addition to non-contact data transfer, wireless communication can also allow non-line-of-sight communication. However, with very HF systems more directionality is evident and can be tailored to needs through appropriate antenna design.

Three frequency ranges are generally distinguished for RFID systems: low, intermediate (medium), and high. The following table summarizes these three frequency ranges, along with the typical system characteristics and examples of major areas of application.

Frequency Band	Characteristics	Typical Applications
Low 100-500 kHz	• Short to Medium Read Range • Inexpensive • Low Reading Speed	• Access Control • Animal Identification • Inventory Control • Car Immobilizer
Intermediate 10 - 15 MHz	• Short to Medium Read Range • Potentially Inexpensive • Medium Reading Speed	• Access Control • Smart Cards
High 850-950 MHz 2.4-5.8 GHz	• Long Read Range • High Reading Speed • Line of Sight Required • Expensive	• Railroad Car Monitoring • Toll Collection Systems

Three carrier frequencies receiving early attention as representative of the low, intermediate, and high ranges are 125 KHz, 13.56 MHz, and 2.45 GHz. However, there are eight frequency bands in use around the world, for RFID applications.

Not all of the countries in the world have access to all of the frequency bands listed above, as some countries have assigned these bands to other users. Within each country and within each frequency range there are specific regulations that govern the use of the frequency. These regulations may apply to power levels and interference as well as frequency tolerances.

Frequency Range	Applications and Comments
Less Than 135 KHz	A wide range of products available to suit a range of applications, including animal tagging, access control and track and traceability. Transponder systems that operate in this band do not need to be licensed in many countries.
1.95 MHz 3.25MHz 4.75MHz 8.2MHz	Electronic article surveillance (EAS) systems used in retail stores.
Approx. 13 MHz 13.56MHz	EAS systems and Industrial, Scientific and Medical (ISM).
Approximately 27 MHz	ISM applications.
430 - 460 MHz	ISM Applications Specifically in Region 1.
902 - 916 MHz	ISM Applications specifically in Region 2. In the USA this band is organized with many different types of applications with different levels of priorities. This includes Railcar and Tool Road applications. The band has been divided into narrow band sources and wide band (spread spectrum type) sources. In Region 1 the Gilbarco Security Module (GSM) telephone network uses the same frequencies.
918 - 926 MHz	RFID in Australia for transmitters with Effective Isotropic Radiated Power (EIRP) less than 1 watt.
2350 - 2450 MHz	A recognized ISM band in most parts of the world. IEEE 802.11 recognizes this band as acceptable for RF communications and both spread spectrum and narrow band systems are in use.
5400 - 6800 MHz	This band is allocated for future use. The FCC has been requested to provide a spectrum allocation of 75 MHz in the 5.85 - 5.925 GHz band for Intelligent Transportation Services use. In France, the TIS system is based on the proposed European pre-standard (preENV) for vehicle to roadside communications communicating with the roadside via microwave beacons operating at 5.8 GHz.

Data Transfer Rate and Bandwidth

Choice of field or carrier wave frequency is of primary importance in determining data transfer rates. In practical terms the rate of data transfer is influenced primarily by the frequency of the carrier wave or varying field used to carry the data between the tag and its reader. Generally speaking the higher the frequency the higher the data transfer or throughput rates that can be achieved. This is intimately linked to bandwidth or range available within the frequency spectrum for the communication process. The channel bandwidth needs to be at least twice the bit rate required for the application in mind. Where narrow band allocations are involved the limitation on data rate can be an important consideration. It is clearly less of an issue where wide bandwidths are involved. Using the 2.4 - 2.5 GHz spread spectrum band, for example, 2 MB per second data rates may be achieved, with added noise immunity provided by the spread spectrum modulation approach. Spread spectrum apart, increasing the bandwidth allows an increase noise level and a reduction in signal-to-noise ratio. Since it is generally necessary to ensure a signal is above the noise floor for a given application, bandwidth is an important consideration in this respect.

Range and Power Levels

The range that can be achieved in an RFID system is essentially determined by:

- The power available at the reader/interrogator to communicate with the tag(s).
- The power available within the tag to respond.
- The environmental conditions and structures, the former being more significant at higher frequencies including signal to noise ratio.

Although the level of available power is the primary determinant of range the manner and efficiency in which that power is deployed also influences the range. The field or wave delivered from an antenna extends into the space surrounding it and its strength diminishes with respect to distance. The antenna design will determine the shape of the field or propagation wave delivered, so that range will also be influenced by the angle subtended between the tag and antenna.

In space free of any obstructions or absorption mechanisms the strength of the field reduces in inverse proportion to the square of the distance. For a wave propagating through a region in which reflections can arise from the ground and from obstacles, the reduction in strength can vary quite considerable, in some cases as an inverse fourth power of the distance. Where different paths arise in this way the phenomenon is known as “Multi-path attenuation”. At higher frequencies absorption due to the presence of moisture can further influence range. It is therefore important in many applications to determine how the environment, internal or external, can influence the range of communication. Where a number of reflective metal “obstacles” are to encountered within the application to be considered, and can vary in number from time to time, it may also be required to establish the implications of such changes through an appropriate environmental evaluation.

The power within the tag is generally speaking a lot less than from the reader, requiring sensitive detection capability within the reader to handle the return signals. In some systems the reader constitutes a receiver and is separate from the interrogation source or transmitter, particularly if the “up-link” (from transmitter-to-tag) carrier is different from the “down-link” (from tag-to-reader).

Although it is possible to choose power levels to suit different application needs is not possible to exercise complete freedom of choice. Like the restrictions on carrier frequencies there are also legislative constraints on power levels. While 100 - 500 mW are values often quoted for RFID systems actual values should be confirmed with the appropriate regulatory authorities, in the countries where the technology is to be applied. The authorities will also be able to indicate the form in which the power is delivered, pulsed or continuous, and the associated allowed values.

Having gained some grasp of the data communication parameters and their associated values it is appropriate to consider, in a little more detail, the components of an RFID system.

Transponders/Tags

The word transponder, derived from TRANSmitter/resPONDER, reveals the function of the device. The tag responds to a transmitted or communicated request for the data it carries, the mode of communication between the reader and the tag being by wireless means across the space or air interface between the two. The term also suggests the essential components that form an RFID system - tags and a reader or interrogator. Where interrogator is often used as an alternative to that of reader, a difference is sometime drawn on the basis of a reader together with a decoder and interface forming the interrogator.

Generally, transponder components are fabricated as low power integrated circuits suitable for interfacing to external coils, or utilizing “coil-on-chip” technology, for data transfer and power generation (passive mode).

Basic Features of RFID Transponder

The transponder memory may comprise Read-only Memory (ROM), Random Access Memory (RAM) and non-volatile programmable memory for data storage depending upon the type and sophistication of the device. The ROM-based memory is used to accommodate security data and the transponder operating system instructions which, in conjunction with the processor or processing logic deals with the internal “house-keeping” functions such as response delay timing, data flow control and power supply switching. The RAM-based memory is used to facilitate temporary data storage during transponder interrogation and response.

The non-volatile programmable memory may take various forms, Electrically Erasable Programmable Read Only Memory (EEPROM) being typical. It is used to store the transponder data and needs to be non-volatile to ensure that the data is retained when the device is in its quiescent or power-saving “sleep” state.

Data buffers are further components of memory, used to temporarily hold incoming data following demodulation and outgoing data for modulation and interface with the transponder antenna. The interface circuitry provides the facility to direct and accommodate the interrogation field energy for powering purposes in passive transponders and triggering of the transponder response. Where programming is accommodated, facilities must be provided to accept the data modulated signal and perform the required demodulation and data transfer processes.

The transponder antenna is the means by which the device senses the interrogating field and, where appropriate, the programming field and also serves as the means of transmitting the transponder response to interrogation.

A number of features, in addition to carrier frequency, characterize RFID transponders and form the basis of device specifications, including:

- Means by which a transponder is powered
- Data carrying options
- Data read rates
- Programming options
- Physical form
- Costs

Powering Tags

Tags require power in order to work, even though the levels are invariably very small (microwatts to milliwatts). Tags are either passive or active, the designation being determined entirely by the manner in which the device derives its power.

Active tags are powered by an internal battery and are typically read/write devices. They usually contain a cell that exhibits a high power-to-weight ratio and are usually capable of operating over a temperature range of -58 °F (-50 °C) to 158 °F (+70 °C). The use of a battery means that a sealed active transponder has a finite lifetime. However, a suitable cell coupled to suitable low power circuitry can ensure functionality for as long as ten or more years, depending upon the operating temperatures, read/write cycles and usage. The trade-off is greater size and greater cost compared with passive tags.

In general terms, active transponders allow greater communication range than can be expected for passive devices, better noise immunity, and higher data transmissions rates when used to power a higher frequency response mode.

Passive tags operate without an internal battery source, deriving the power to operate from the field generated by the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade-off is that they have shorter read ranges than active tags and require a higher-powered reader. Passive tags are also constrained in their capacity to store data and the ability to perform well in electromagnetically noisy environments. Sensitivity and orientation performance may also be constrained by the limitation on available power. Despite these limitations, passive transponders offer advantages in terms of cost and longevity. They have an almost indefinite lifetime and are generally lower on price than active transponders.

Data Carrying Options

Data stored in data carriers invariable require some organization and additions, such as data identifiers and error detection bits, to satisfy recovery needs. This process is often referred to as source encoding. Standard numbering systems, such as Uniform Code Council (UCC)/European Article Numbering (EAN) and associated data defining elements may also be applied to data stored in tags. The amount of data will of course depend on application and require an appropriate tag to meet the need. Basically, tags may be used to carry:

- Identifiers, in which a numeric or alphanumeric string is stored for identification purposes or as an access key to data stored elsewhere in a computer or information management system, or
- Portable data files, in which information can be organized, for communication or as a means of initiating actions without recourse to, or in combination with, data stored elsewhere.

In terms of data capacity tags can be obtained that satisfy needs from single bit to kilobits. The single bit devices are essentially for surveillance purposes. Retail EAS is the typical application for such devices, being used to activate an alarm when detected in the interrogating field. They may also be used in counting applications.

Devices characterized by data storage capacities up to 128 bits are sufficient to hold a serial or identification number together, possibly, with parity check bits. Such devices may be manufacturer or user programmable. Tags with data storage capacities up to 512 bits, are invariably user programmable, and suitable for accommodating identification and other specific data such as serial numbers, package content, key process instructions or possibly results of earlier interrogation/response transactions.

Tags characterized by data storage capacities of around 64 kilobyte may be regarded as carriers for portable data files. With increased capacity the facility can also be provided for organizing data into fields or pages that may be selectively interrogated during the reading process.

Data Read Rate

It has already been mentioned that data transfer rate is essentially linked to carrier frequency. The higher the frequency, generally speaking, the higher the transfer rates. It should also be appreciated that reading or transferring the data requires a finite period of time, even if rated in milliseconds, and can be an important consideration in applications where a tag is passing swiftly through an interrogation or read zone.

Data Programming Options

Depending upon the type of memory a tag contains, the data carried may be Read-only, Write Once Read Many (WORM) or read/write. Read-only tags are invariably low capacity devices programmed at source, usually with an identification number. WORM devices are user programmable devices. Read/write devices are also user-programmable but allowing the user to change data stored in a tag. Portable programmers may be recognized that also allow in-field programming of the tag while attached to the item being identified or accompanied.

Physical Form

RFID tags come in a wide variety of physical forms, shapes sizes and protective housings. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and ten millimeters in length. Tags can be screw-shaped to identify trees or wooden items, or credit card shaped for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are also RFID tags, as are heavy-duty 120X100X50 mm rectangular transponders used to track inter-modal containers, or heavy machinery, trucks, and railroad cars for maintenance and tracking applications.

Costs

The cost of tags obviously depends upon the type and quantities that are purchased. For large quantities (tens of thousands), the price can range from less than a few tens of pence for extremely simple tags to tens of pounds for the larger and more sophisticated devices. Increasing complexity of circuit function, construction, and memory capacity will influence cost of both transponders and reader/programmers.

The manner in which the transponder is packaged to form a unit will also have a bearing on cost. Some applications where harsh environments may be expected, such as steel mills, mines, and car body paint shops, will require mechanically robust, chemical and temperature tolerant packaging. Such packaging will undoubtedly represent a significant proportion of the total transponder cost. Generally, low frequency transponders are cheaper than HF devices; passive transponders are usually cheaper than active transponders.

Reader/Interrogator

The reader/interrogators can differ quite considerably in complexity, depending upon the type of tags being supported and the functions to be fulfilled. However, the overall function is to provide the means of communicating with the tags and facilitating data transfer. Functions performed by the reader may include quite sophisticated signal conditioning, parity error checking and correction. After the signal from a transponder has been correctly received and decoded, algorithms may be applied to decide whether the signal is a repeat transmission, and may then instruct the transponder to cease transmitting. This is known as the “Command Response Protocol” and is used to circumvent the problem of reading multiple tags in a short space of time. Using interrogators in this way is sometimes referred to as “Hands Down Polling”.

An alternative, more secure, but slower tag polling technique is called “Hands Up Polling” which involves the interrogator looking for tags with specific identities, and interrogating them in turn. This is contention management, and a variety of techniques have been developed to improve the process of batch reading. A further approach may use multiple readers, multiplexed into one interrogator, but with attendant increases in costs.

RF Transponder Programmers

Transponder programmers are the means by which data is delivered to WORM and read/write tags. Programming is generally carried out off-line, at the beginning of a batch production run, for example.

For some systems, reprogramming may be carried out on-line, particularly if it is being used as an interactive portable data file within a production environment. For example, Data may need to be recorded during each process. Removing the transponder at the end of each process to read the previous process data, and to program the new data would naturally increase process time and would detract substantially from the intended flexibility of the application. By combining the functions of a reader/interrogator and a programmer, data may be appended or altered in the transponder as required, without compromising the production line.

The range over which the programming can be achieved is generally less than the read range and in some systems near contact positioning is required. Programmers are also generally designed to handle a single tag at a time. However, developments are now satisfying the need for selective programming of a number of tags present within the range of the programmer.

RFID System Categories

RFID systems may be roughly grouped into four categories:

- EAS systems
- Portable Data Capture systems
- Networked systems
- Positioning systems

EAS systems are typically a one-bit system used to sense the presence/absence of an item. The large use for this technology is in retail stores where each item is tagged and large antenna readers are placed at each exit of the store to detect unauthorized removal of the item (theft).

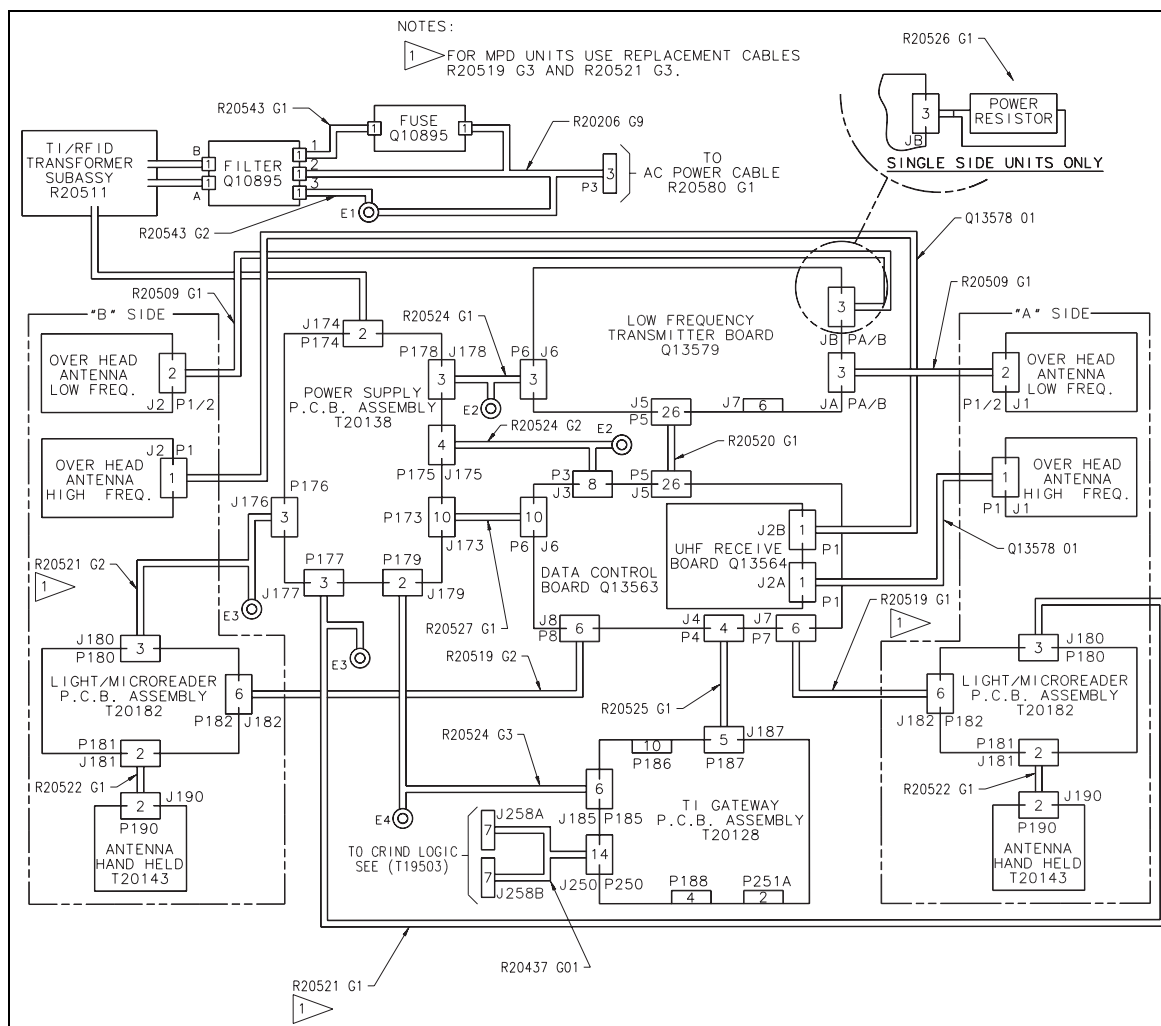
Portable data capture systems are characterized by the use of portable data terminals with integral RFID readers and are used in applications where a high degree of variability in sourcing required data from tagged items may be exhibited. The hand-held readers/portable data terminals capture data which is then either transmitted directly to a host information management system via a Radio Frequency Data Communication (RFDC) link or held for delivery by line-linkage to the host on a batch processing basis.

Networked systems applications can generally be characterized by fixed position readers deployed within a given site and connected directly to a networked information management system. The transponders are positioned on moving or moveable items, or people, depending upon application.

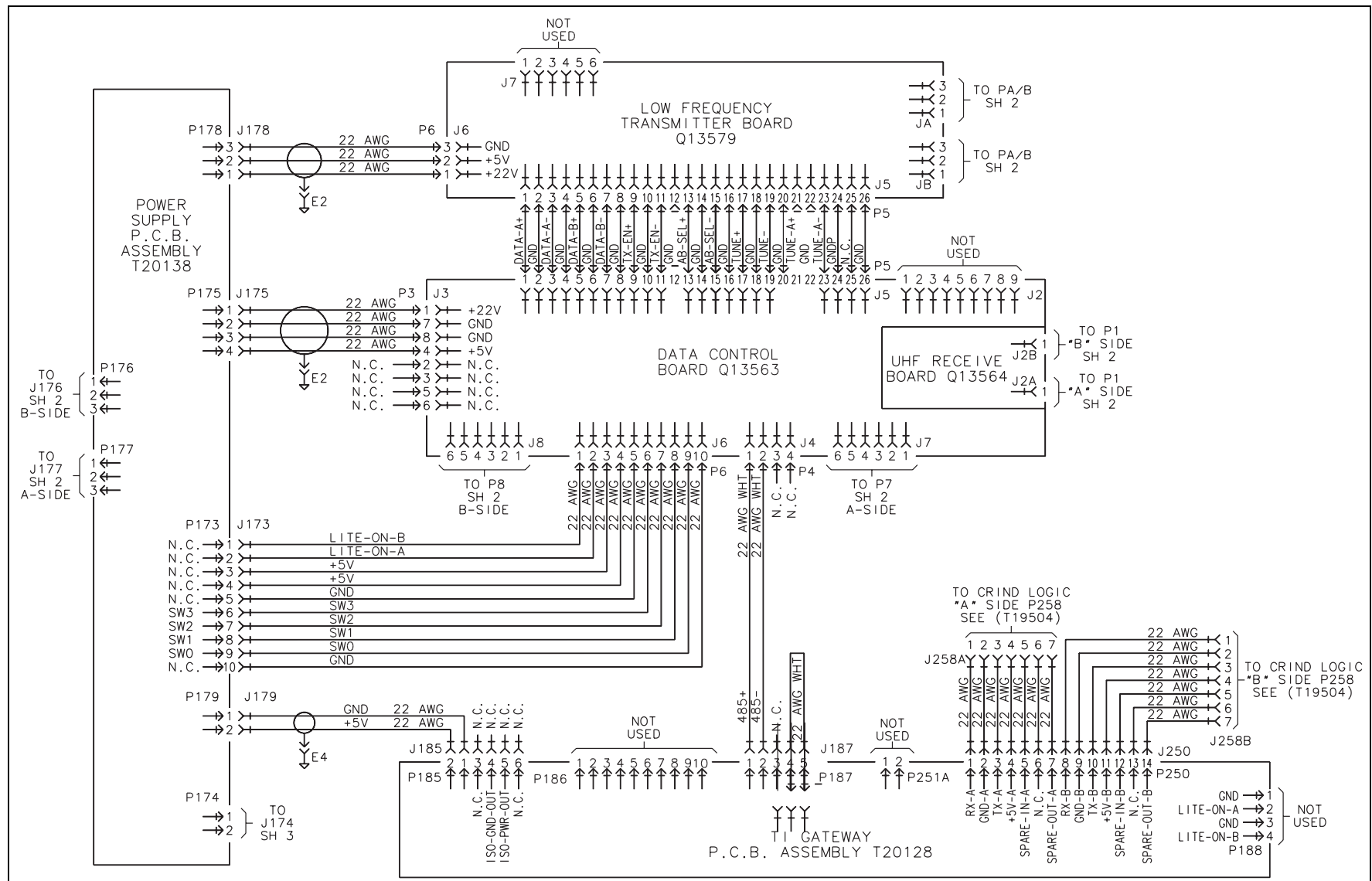
Positioning systems use transponders to facilitate automated location and navigation support for guided vehicles. Readers are positioned on the vehicles and linked to an on-board computer and RFDC link to the host information management system. The transponders are embedded in the floor of the operating environment and programmed with appropriate identification and location data. The reader antenna is usually located beneath the vehicle to allow closer proximity to the embedded transponders.

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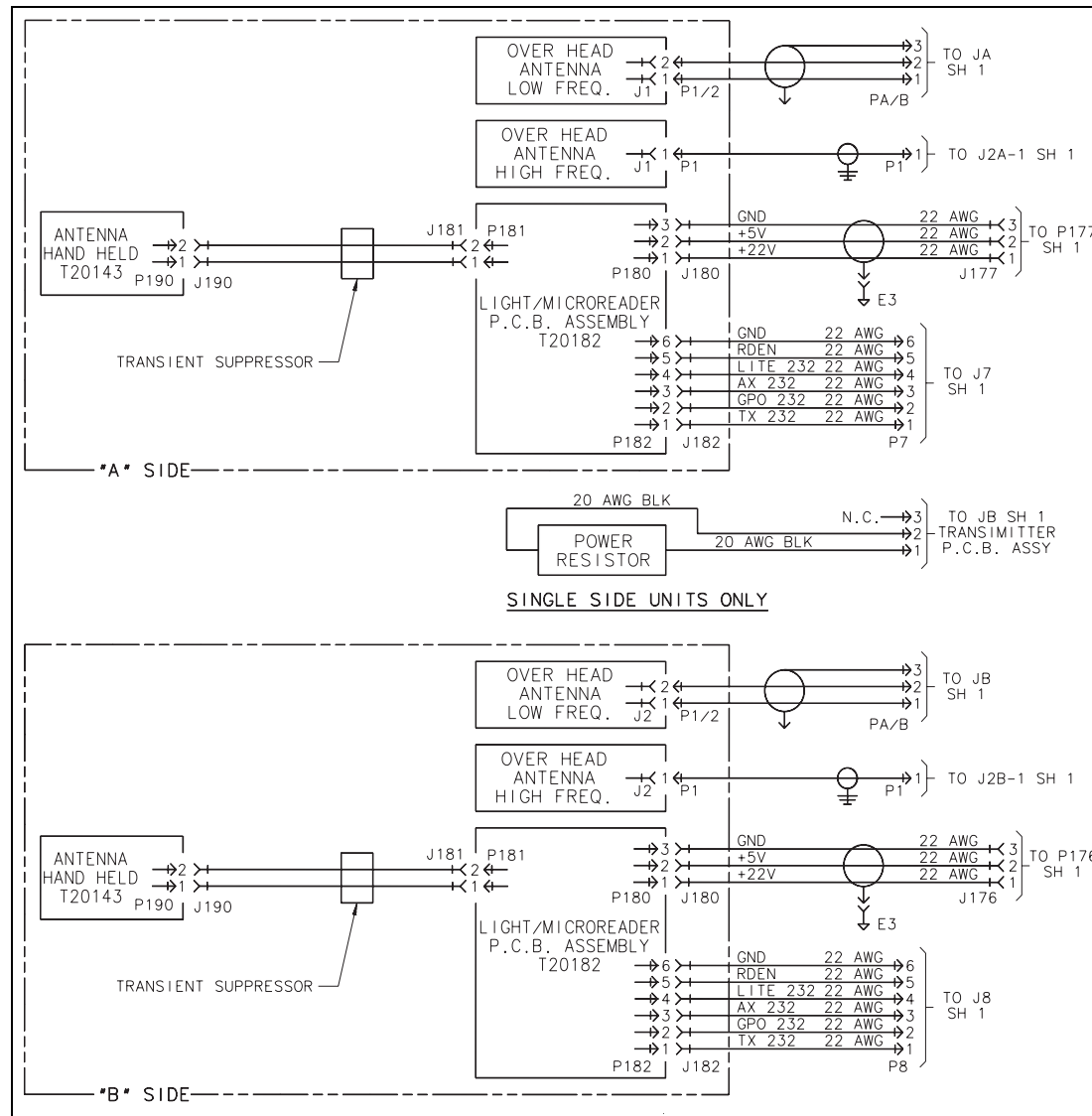
R20515 Cable Block Diagram, Revision F



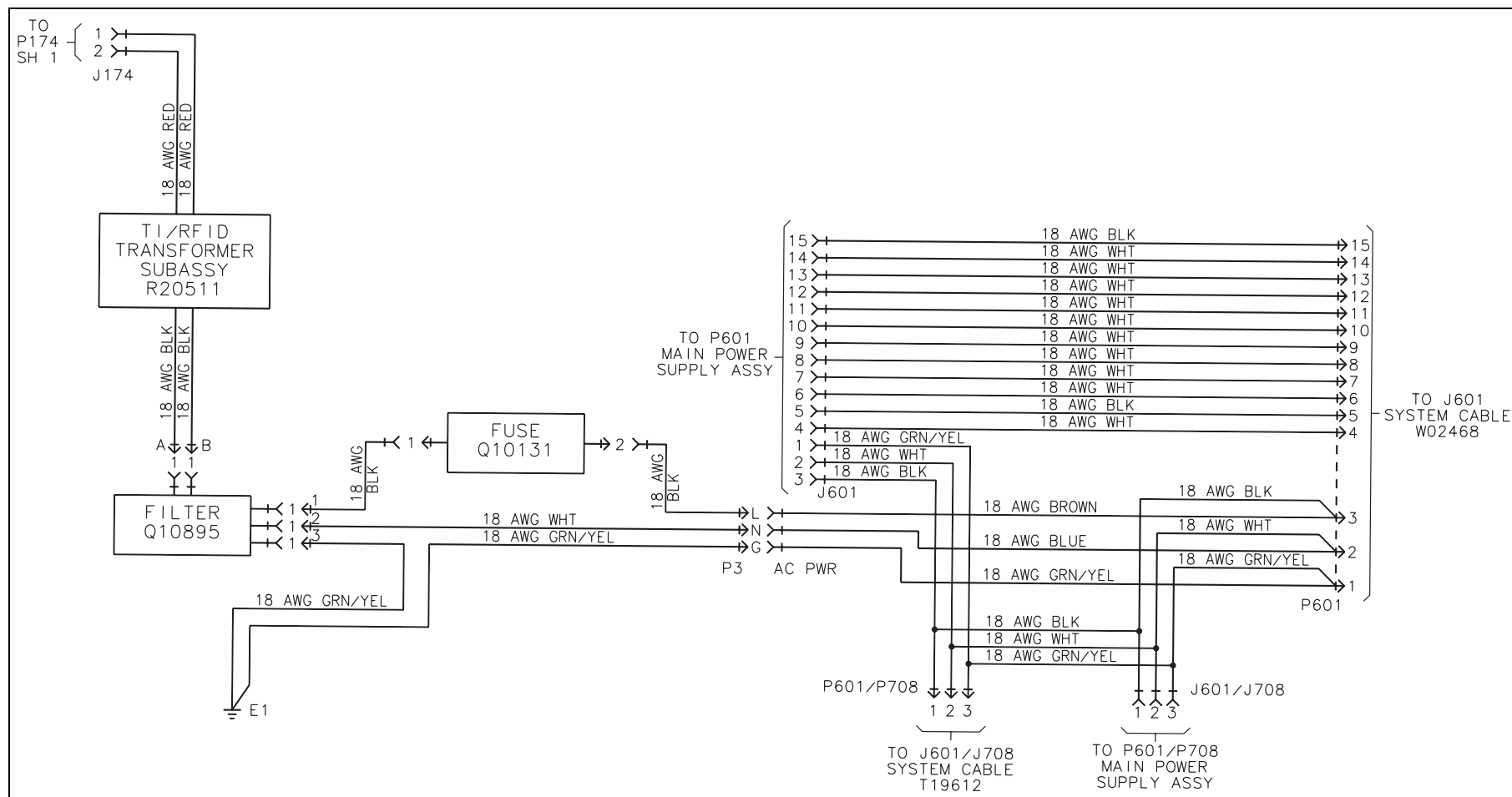
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R20516 Interconnect Diagrams, Sheet 2 of 3, Revision C

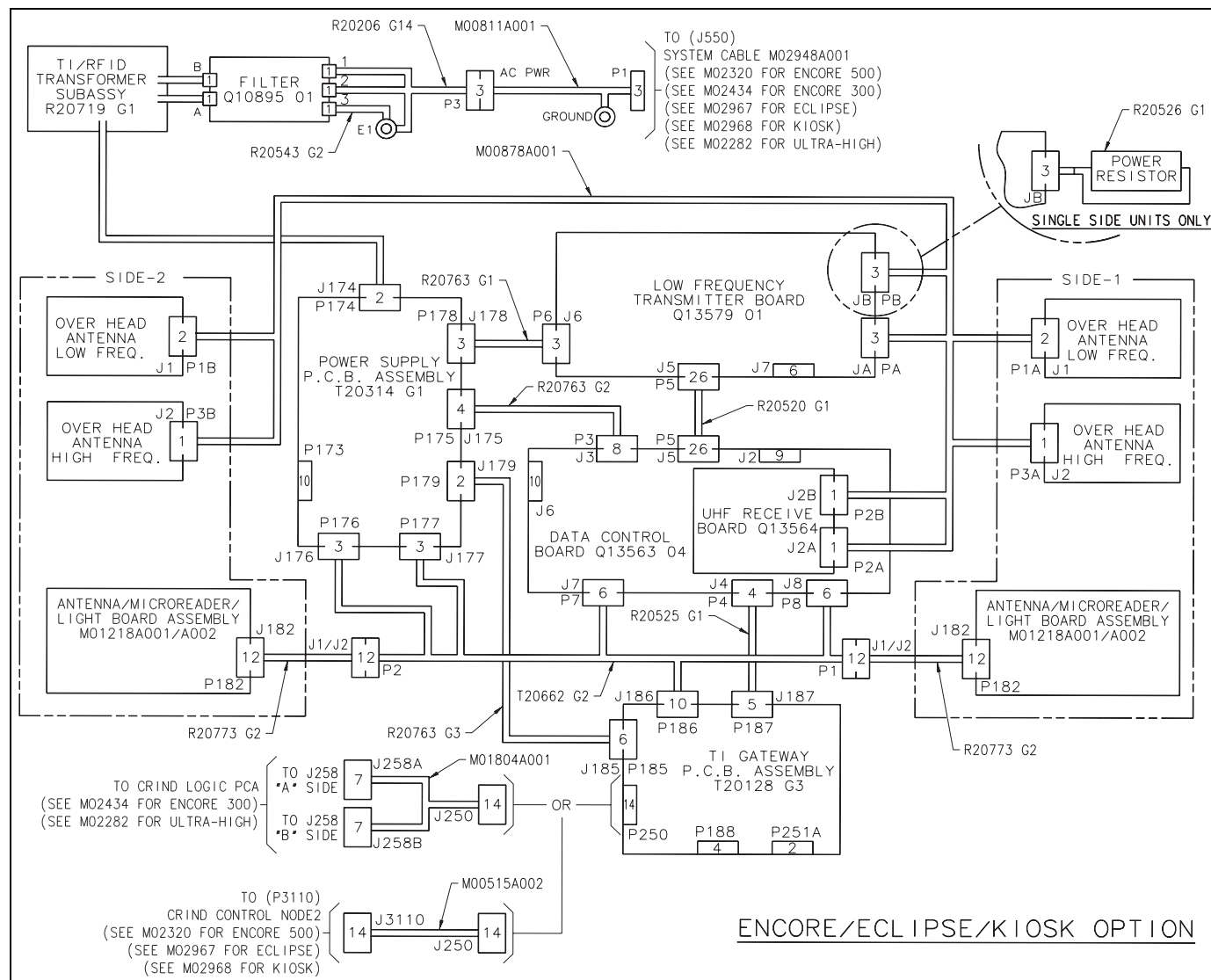


R20516 Interconnect Diagrams, Sheet 3 of 3, Revision E

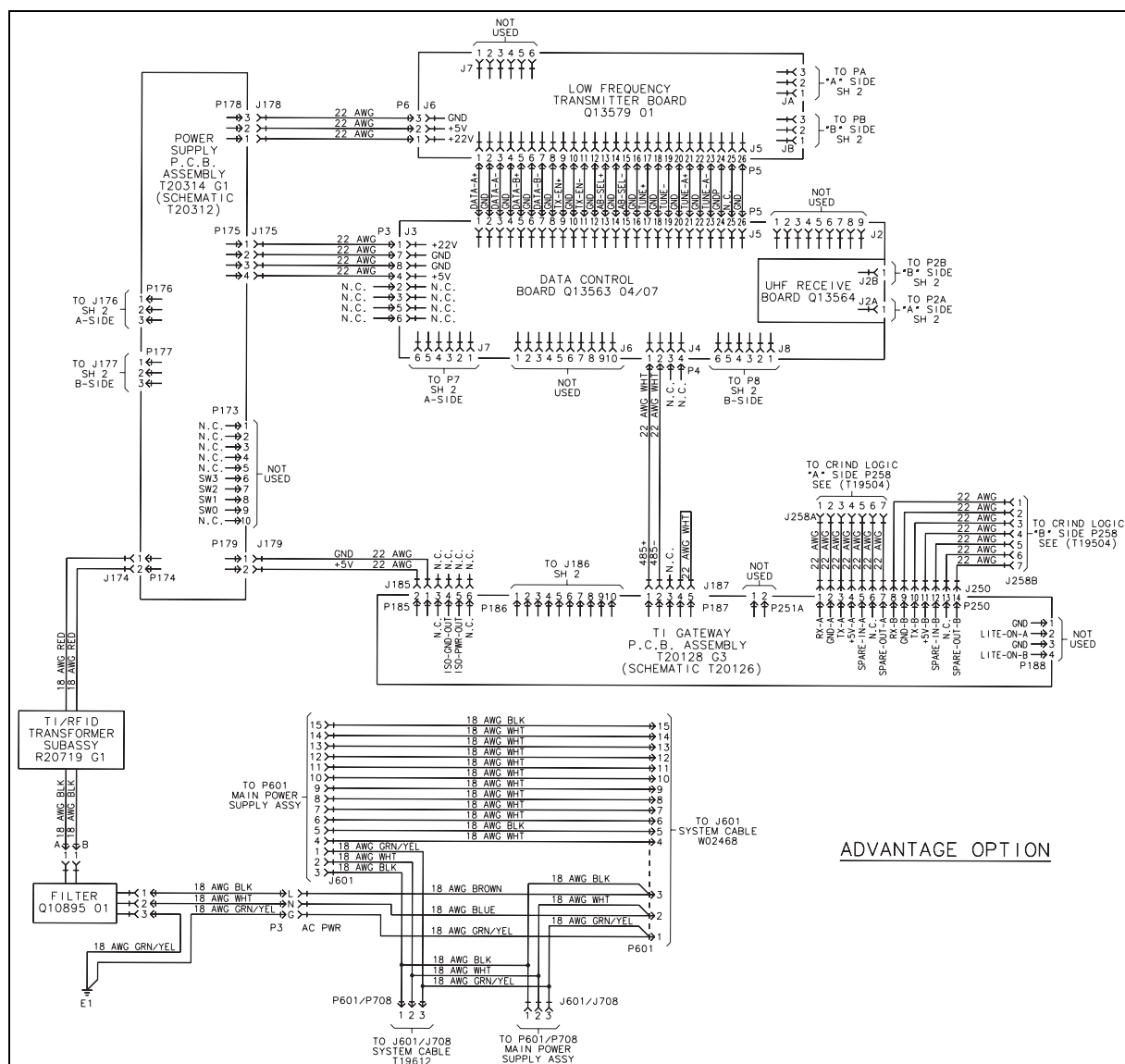


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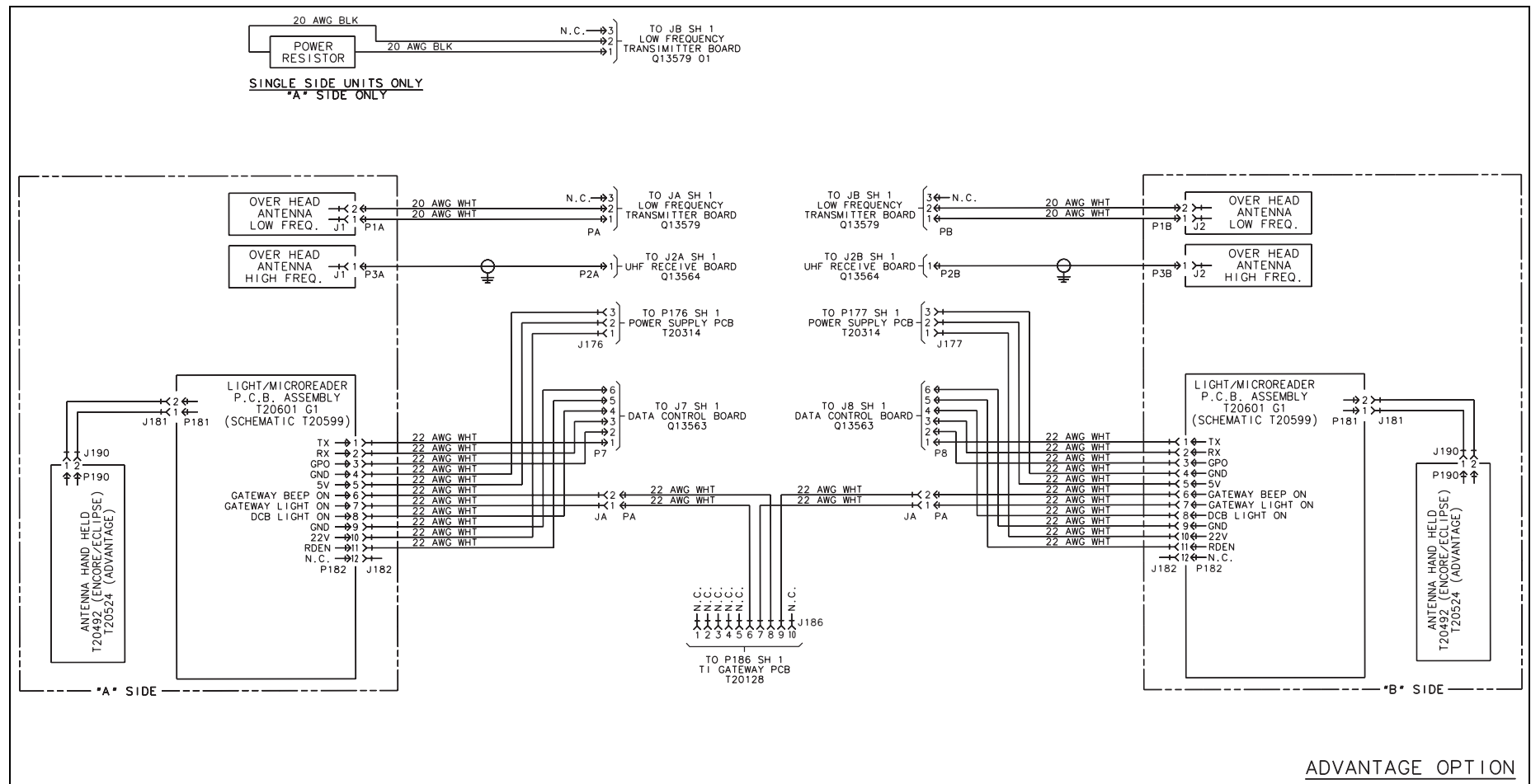
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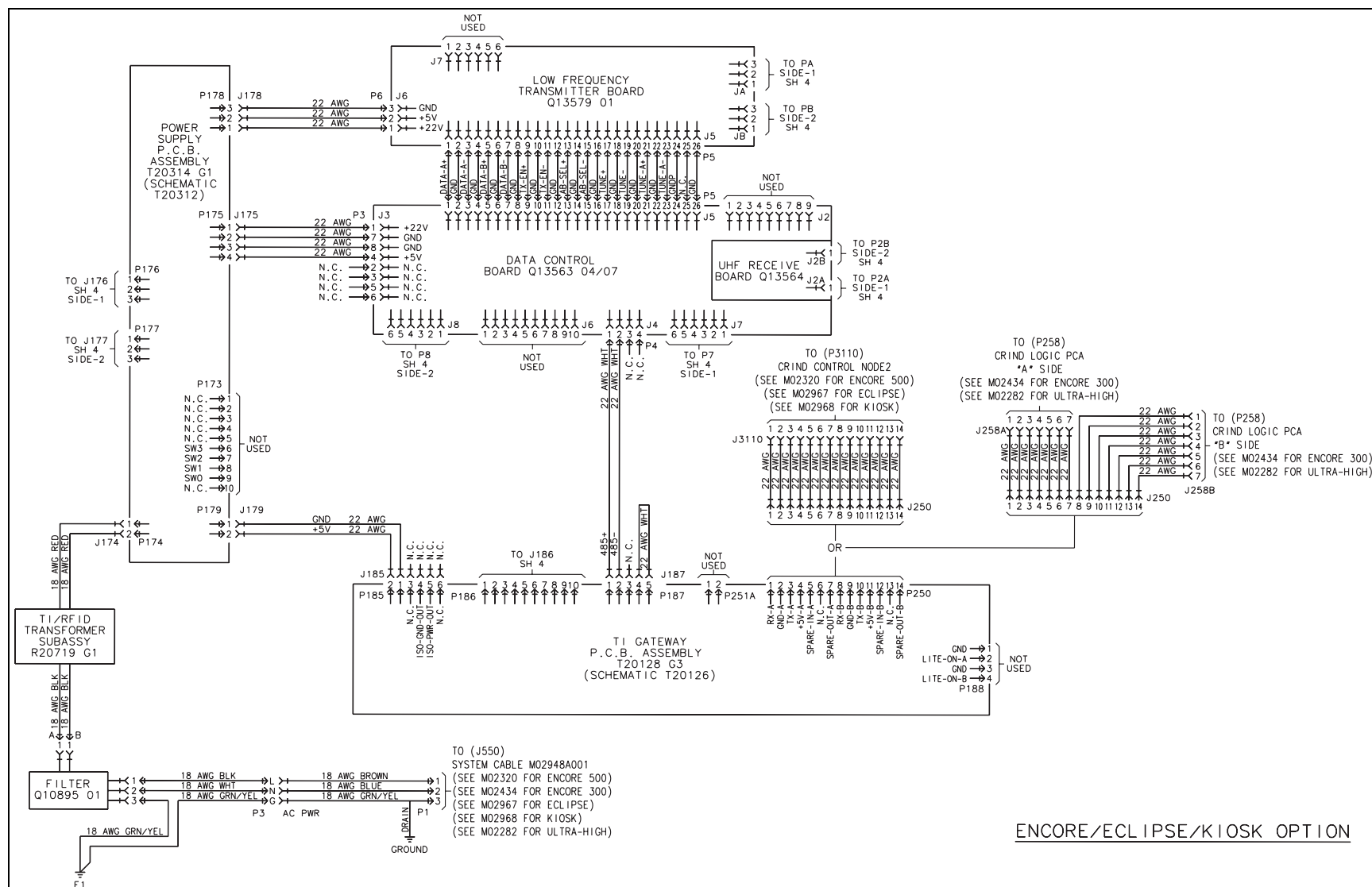
Page B-7



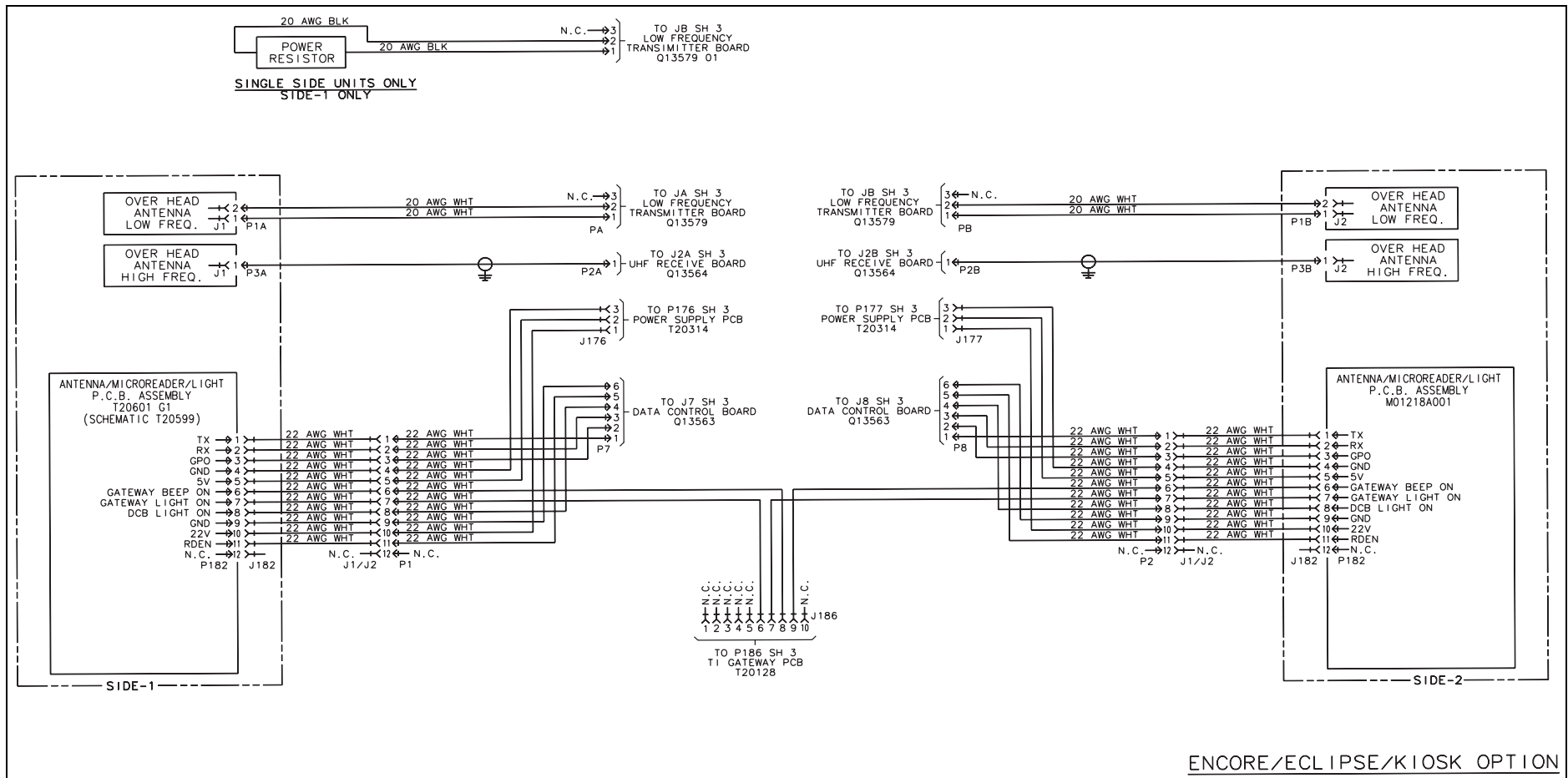
T20607 Interconnection Diagrams, Sheet 2 of 4, Revision H



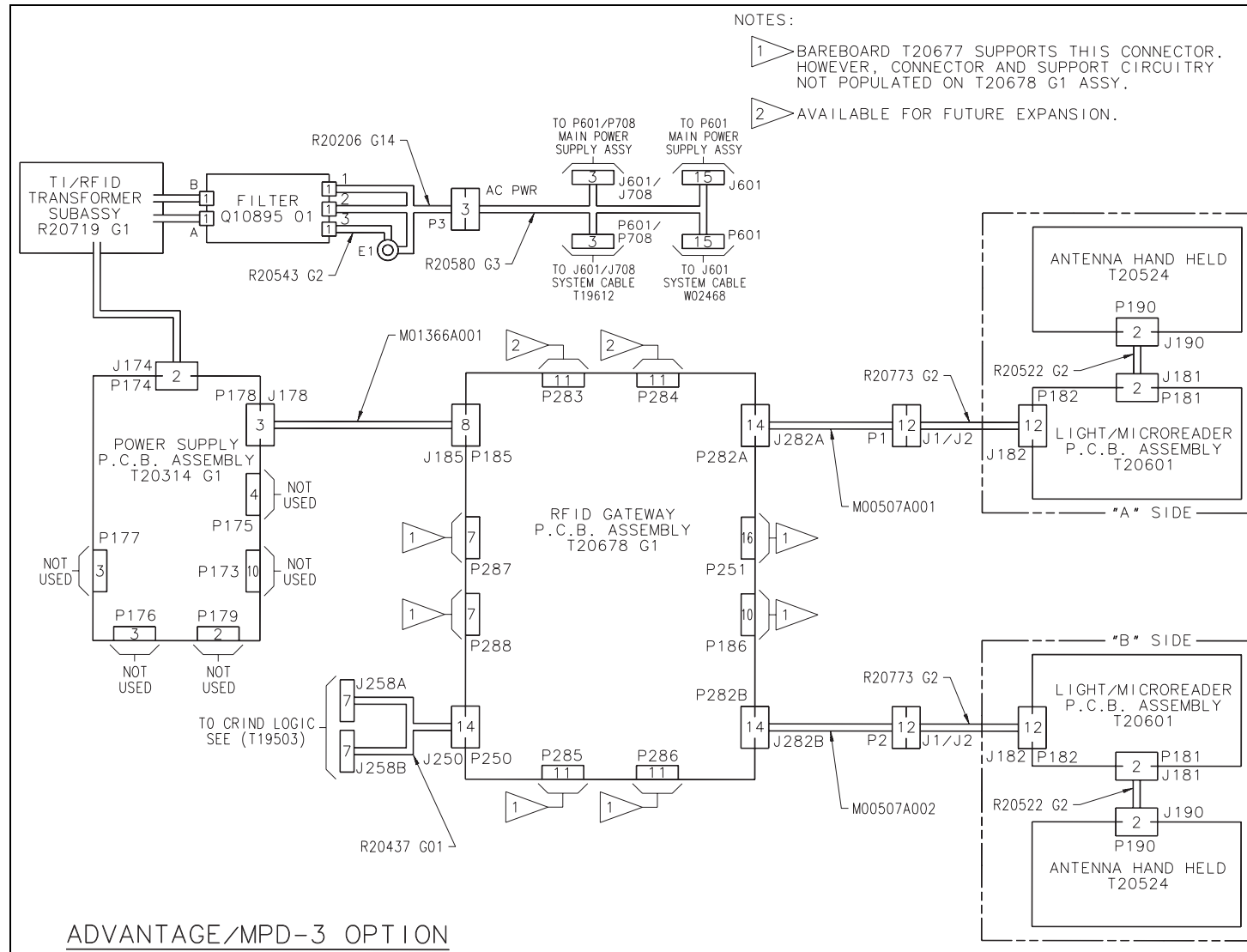
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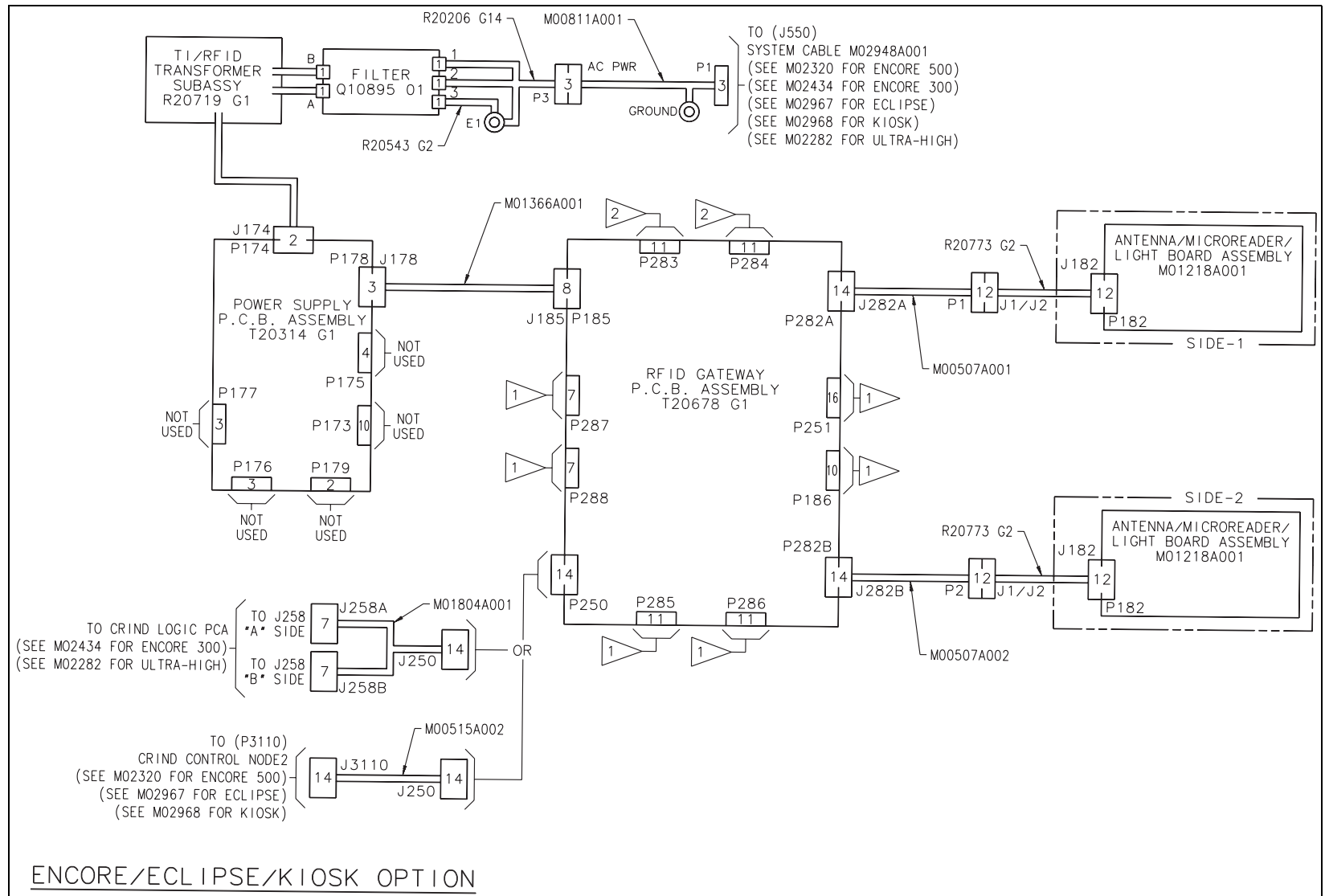
T20607 Interconnection Diagrams, Sheet 4 of 4, Revision H



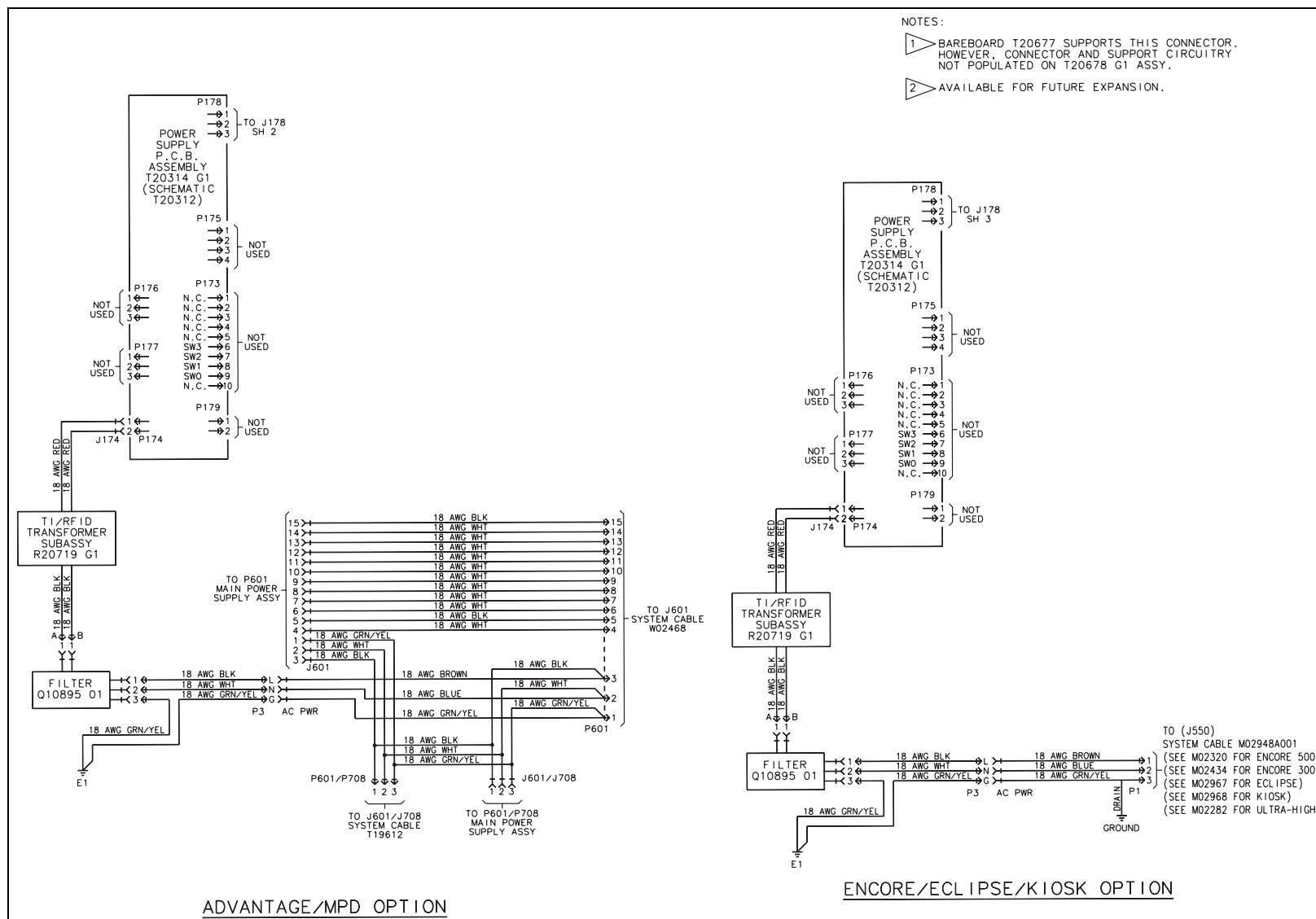
R20775 Cable Block Diagrams, Sheet 1 of 2, Revision D



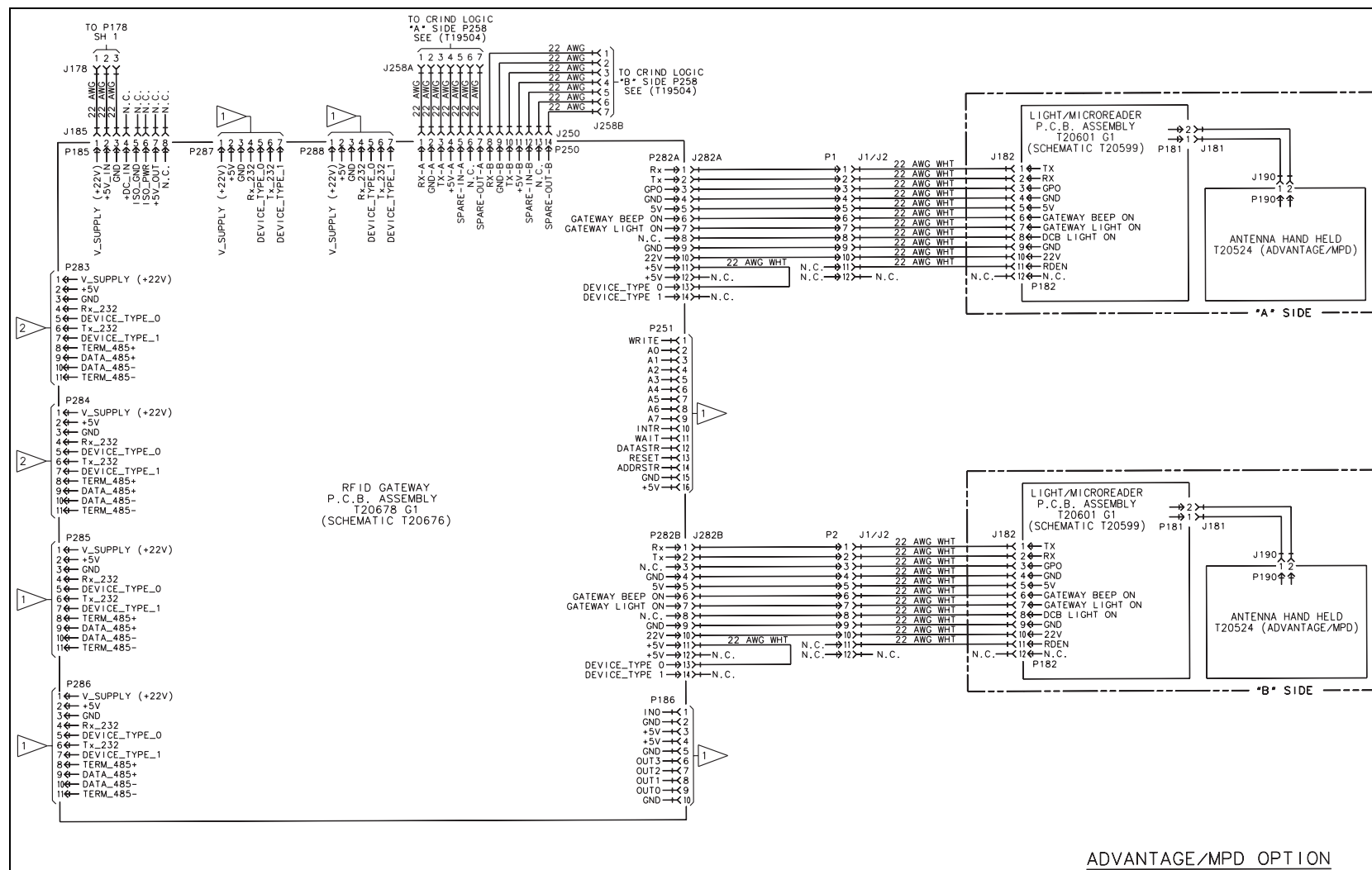
R20775 Cable Block Diagrams, Sheet 2 of 2, Revision D



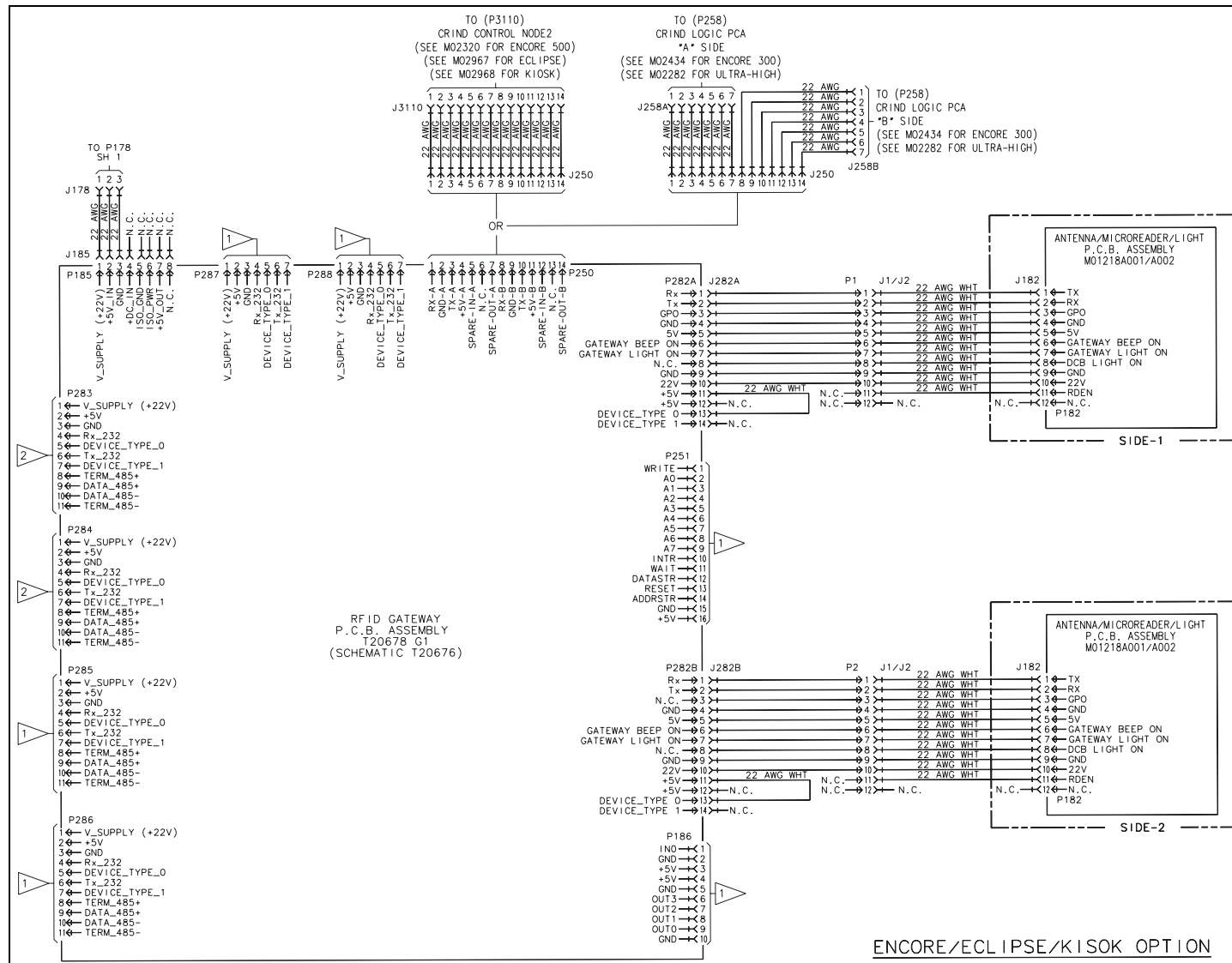
T20663 Interconnect Diagrams, Sheet 1 of 3, Revision C



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T20663 Interconnection Diagrams, Sheet 3 of 3, Revision C



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