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FTS 400/800
Approach Lighting Systems

Reference Manual

Front Matter

Abstract

This manual contains information and instructions for installing, operating, and maintaining the FTS 400 and 800 Approach Lighting Systems manufactured by Flash Technology[®], a Dielectric Company.

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Applicable Specification

This equipment meets or exceeds requirements for an FAA Type L-849 Styles A, C, and E, and Type L-859, Styles B, D, and F.

Disclaimer

While every effort has been made to ensure that the information in this manual is complete, accurate and up-to-date, Flash Technology assumes no liability for damages resulting from any errors or omissions in this manual, or from the use of the information contained herein. Flash Technology reserves the right to revise this manual without obligation to notify any person or organization of the revision.

In no event will Flash Technology be liable for direct, indirect, special, incidental, or consequential damages arising out of the use of or the inability to use this manual.

Warranty

Flash Technology warrants all components, under normal operating conditions, for two years.

Replacement Parts

The use of parts not manufactured or supplied by Flash Technology or unauthorized modification of this equipment voids the warranty and could invalidate the assurance of complying with FAA requirements for Type L-849 Style A and E lights as published in Advisory Circular 150/5345-51.

Pub. No. 0594-400/800-0009

PERSONNEL HAZARD WARNING

Dangerous Voltages

Dangerous line voltages reside in certain locations in this equipment. Also, this equipment may generate dangerous voltages. Although FTCA has incorporated every practical safety precaution, exercise extreme caution at all times when you expose circuits and components, and when you operate, maintain, or service this equipment.

Avoid Touching Live Circuits

Avoid touching any component or any part of the circuitry while the equipment is operating. Do not change components or make adjustments inside the equipment with power on.

Dangerous Voltages Can Persist with Power Disconnected

Under certain conditions, dangerous voltages can be present because capacitors can retain charges even after the power has been disconnected. Protect yourself — always turn off the input (primary) power and wait for one minute for storage capacitors to drain their charge. Then check between the red and blue wires on the TB2 terminal block with a voltmeter for any residual charge before touching any circuit element or component.

Do Not Depend on Interlocks

Never depend on interlocks alone to remove unsafe voltages. Always check circuits with a voltmeter. Under no circumstances remove or alter any safety interlock switch.

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Section 1 — Introduction and Operation

System

FTS 400 System: An FTS 400 Approach Lighting System consists of two or more lighting units. Each lighting unit is composed of an FH 400 Flashhead and PC 400 Power Converter. One of the power converters in the system is either a PC 410 with an FTC 415 Internal Controller or a PC 420 with an FTC 425 External Controller; these are the master power converters. Power converters without controllers are slaves known as PC 400-2 Power Converters.

FTS 800 System: An FTS 800 Approach Lighting System consists of two or more lighting units. Each lighting unit is composed of an FH 800 Flashhead and PC 800 Power Converter. One of the power converters in the system is either a PC 810 with an FTC 415 Internal Controller or a PC 820 with an FTC 425 External Controller; these are master power converters. Power converters without controllers are slaves known as PC 800-2 Power Converters.

The FH 400 Flashhead produces a beam covering 360 degrees horizontally and 8 degrees, or more, vertically. The lens directs the main part of the beam upward toward the airways, while limiting stray light toward the ground.

The FH 800 Flashhead directs the beam 30 degrees horizontally and 10 degrees vertically. The flashhead is attached to a two-inch threaded pipe by a yoke that has provisions for horizontal and vertical aiming and locking.

In ALS applications, the lights are aligned with the center line of the runway and flash sequentially toward the landing threshold. An ALS installation may have from 3 to 21 (or more) sequentially flashing lights.

A REIL (Runway End Identifier Lights) system consists of only two lights that are located on each

side of the runway at the landing threshold. The REIL lights flash (simultaneously) after the last center line light has flashed.

The lights can be used in a combined ALS and REIL configuration.

Specifications

Physical:

Heights include dimensions of the units only and do not include the distance from the bottom of each unit to the ground.

FTS 400 Comounted Assembly:

(H x W x D) 29 x 25 x 14 in., 25 lbs.
724 x 635 x 356 mm, 11.5 kg.

FTS 800 Comounted Assembly:

(H x W x D) 25 x 25 x 14 in., 25 lbs.
622 x 635 x 356 mm, 11.53 kg.

PC 400-2 or PC 800-2 Power Converter:

(H x W x D) 12.3 x 19.5 x 13.5 in., 21 lbs.
311 x 494 x 341 mm, 9.53 kg.

FH 400 Flashhead:

(H x W x D) 16.5 x 13.5 x 13.5 in., 10 lbs.
419 x 343 x 343 mm., 4.5 kg.

FH 800 Flashhead:

(H x W x D) 10.8 x 7.80 in., 4 lbs.
226 x 198 mm, 1.82 kg.

Performance Characteristics:

Power Requirements:

Voltage and Frequency	120 VAC, 60 Hz
Volt-Amperes	300 VA peak
FTS 400 Power Req.	105 W high int. 65 W medium int. 50 W low int.
FTS 800 Power Req.	120 fps 190 W high int. 75 W medium int. 55 W low int. 60 fps 135 W high int. 65 W medium int. 50 W low int.

Flash Intensity:

FTS 400:

High Intensity	5,000 cd
Medium Intensity	1,500 cd
Low Intensity	300 cd

FTS 800:

High Intensity	15,000 cd
Medium Intensity	1500 cd
Low Intensity	300 cd

Flash Rate:

FTS 400 60 flashes per minute

FTS 800 120 flashes per minute

Flash Coverage:

FH 400:

Horizontal	360 degrees
Vertical	8 degrees (minimum)

FH 800:

Horizontal	30 degrees (minimum)
Vertical	10 degrees (minimum)

Application: L-849

Radio Interface: L-854

Control Interface:

FTC 415 Internal Controller; or
FTC 425 External Controller (requires
CI 425 interface panel)

Control Type:

Master/slave with common reference
timing.

Monitoring & Environmental:

Complies with FAA Advisory
CircularAC 150/5345-51.

Elapsed Time Meter

The Elapsed Time Meter shows the hours of operation at high intensity. You can use this timer, for example, to schedule inspections, cleaning, or flashtube replacement as preventive maintenance.

Flash Monitor

The Flash Monitor allows monitoring flash operation with external monitoring equipment. The main terminal block TB1 has two connections at

TB1-4 and TB1-5 to which you can connect the monitoring device. These contacts open upon failure of the flashtube for more than approximately 12 seconds. When you first turn the unit on, a failure may be indicated for about 12 seconds until the monitor detects sufficient flashes to close the contacts. After this initial period, the contacts remain closed until a failure occurs or the power is removed.

FTC 435 Controller

The FTC 435 is a series-fed current-operated external controller for the master lighting unit. A switch on its front panel controls low, medium, and high light intensity, or allows control from current steps in a constant current regulator.

Operation

ElectroFlash ODALS and REIL systems can use either an external FTC 425 Controller, which is housed in its own separate enclosure, or an FTC 415 Internal Controller, which is combined with one of the power converters. You can locate an external FTC 425 Controller any practical distance from the rest of the system. It interfaces with a CI 425 Control Interface Panel installed in the “master” power converter.

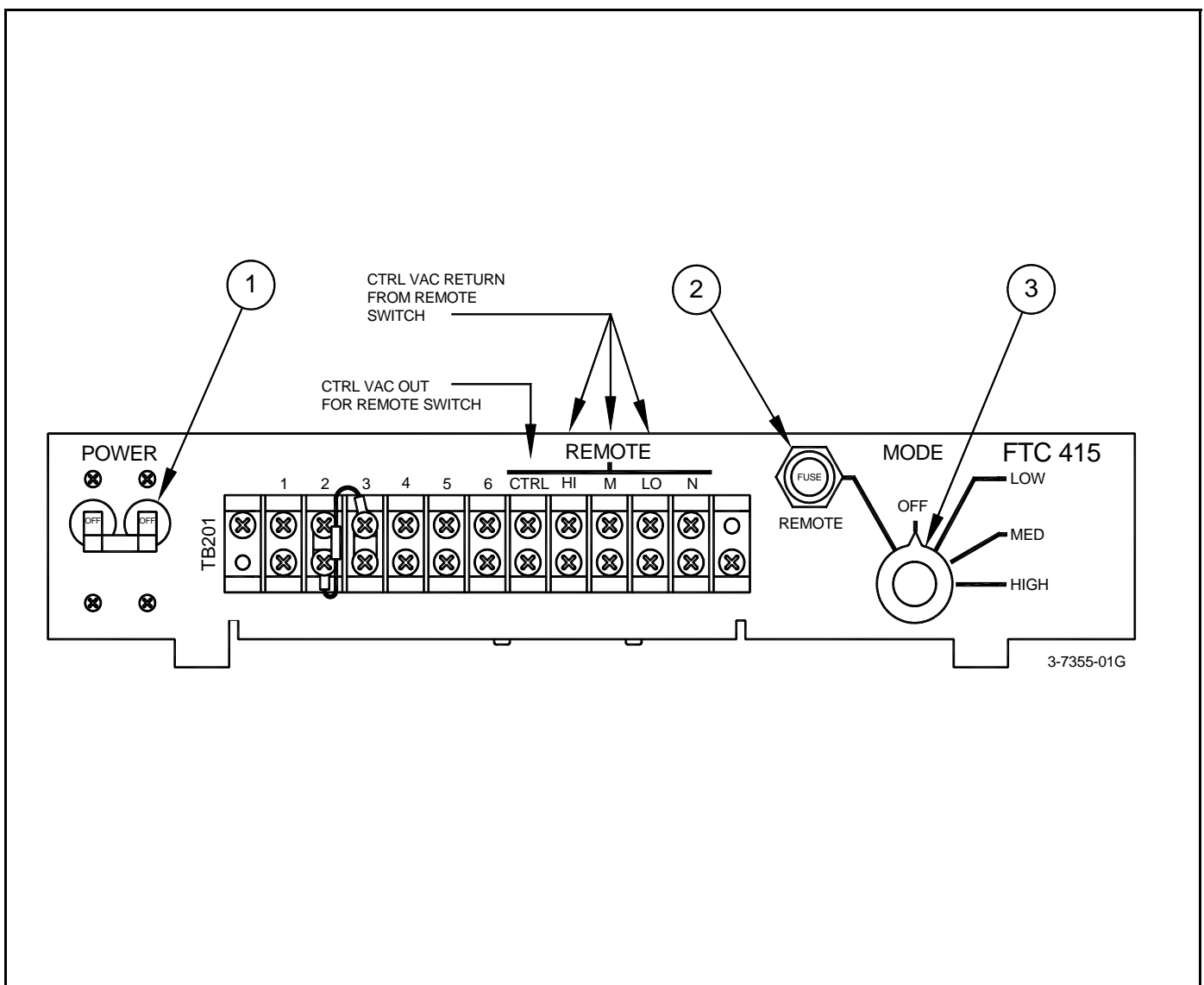
Each lighting unit (power converter) has internal timing circuitry to fix the instant at which it flashes. This signal also contains encoded flash intensity information. A *control* line, which enables sequential flashing, interconnects all the lights.

Controls and Indicators

Table 1-1 describes controls for the FTC 415 Internal Controller, and *Figure 1-1* shows these controls. *Table 1-2* describes and *Figure 1-2* illustrates controls and indicators for the FTC 425 External Controller.

Table 1-1 FTC 415 Internal Controller—Controls

Item	Description	Function
1	Power Circuit Breaker	Applies AC power to the lighting system.
2	Remote Control Fuse	Protects the remote control AC line.
3	MODE Selector	Selects one of five operating modes: <ul style="list-style-type: none"> • REMOTE places the system in remote control mode, controlled at another location. • OFF removes power from the lighting units. • LOW activates flashing at low intensity. • MED activates flashing at medium intensity. • HIGH activates flashing at high intensity.



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Figure 1-1 FTC 415 Internal Controller - Controls and Indicators

Table 1-2 FTC 425 External Controller—Controls and Indicators

Item	Description	Function
1	Power Circuit Breaker	Applies AC power to the lighting system.
2	Remote Control Line Fuse	Protects the remote control AC line.
3	Mode Selector	Selects one of five operating modes: <ul style="list-style-type: none"> • REMOTE places the system in remote control mode, controlled at another location. • OFF removes power from the lighting units. • LOW activates flashing at low intensity. • MED activates flashing at medium intensity. • HIGH activates flashing at high intensity.
4	Mode Indicator Lamps	Indicate the selected flashing intensity: <ul style="list-style-type: none"> • LOW indicates that lights are flashing at low intensity. • MED indicates that lights are flashing at medium intensity. • HIGH indicates that lights are flashing at high intensity.

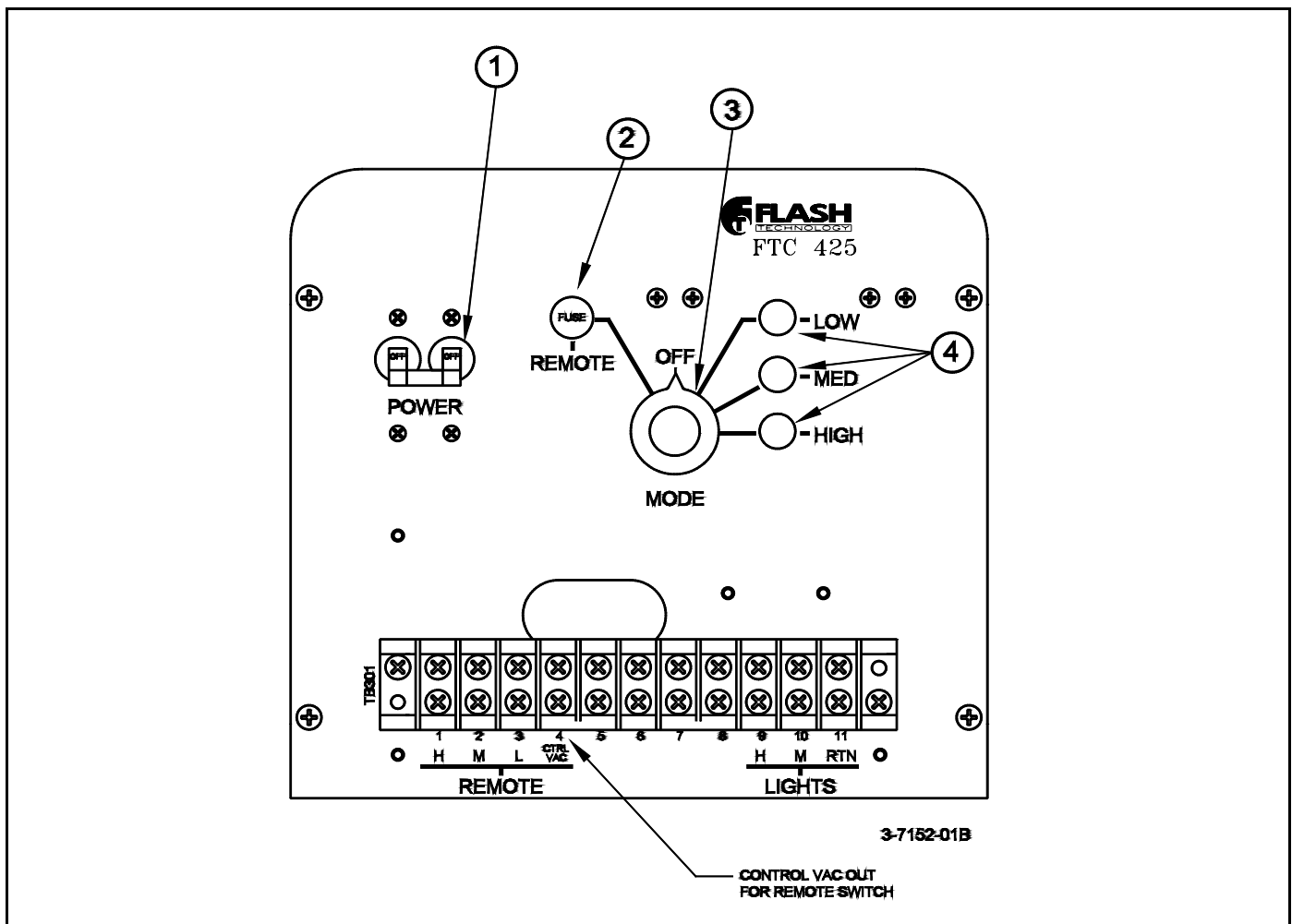
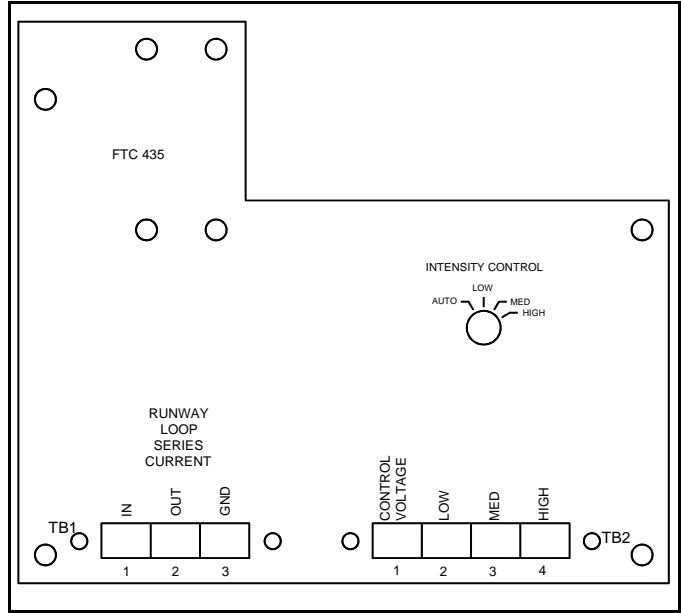


Figure 1-2 FTC 425 External Controller - Controls and Indicators

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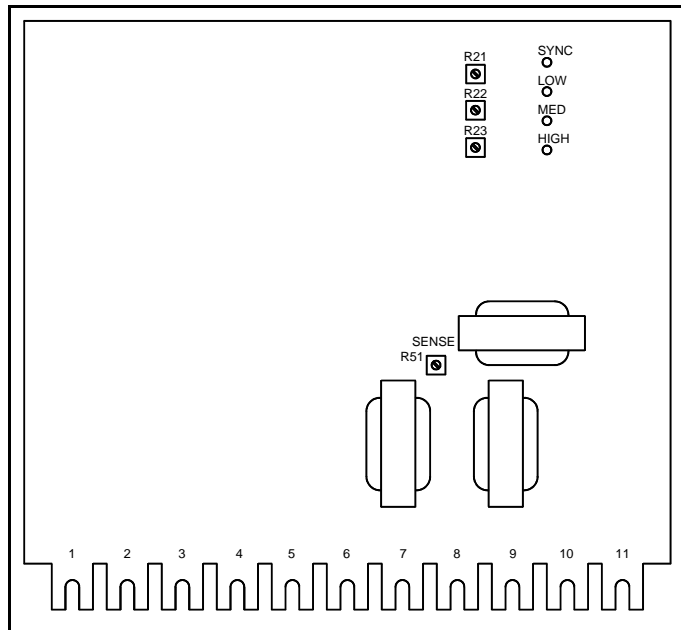
Setting Up the FTC 435 Series Controller

For the following procedures, refer to *Figure 1-3* and *Figure 1-4*.



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Figure 1-3 FTC 435 Series Controller - Controls



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Figure 1-4 FTC 435 Series Controller - Current Sense Board

Note the following abbreviations:

- CCR (Constant Current Regulator)
- CCW (Counterclockwise)
- CW (Clockwise)
- LED (Light Emitting Diode)

The FTC 435 Series Controller can be set up for three-intensity operation using a Constant Current Regulator Type L-828, Class 1 (6.6 amps.): Style 1 (Three Step); Style 1 (Two Step); or Style 2 (Five Step). To set up the FTC 435 Series Controller, use the following procedure:

Style 1 Current Regulator — Three Intensity Levels

For this style, the lighting system switches off only when the CCR is switched off.

1. Turn the SENSE control fully CCW.
2. Turn the HIGH, MED, and LOW controls fully CW.
3. Set the CCR to STEP 1 and adjust the LOW pot CCW until LOW LED just comes on.
4. Set the CCR to STEP 2 and adjust MED pot CCW until the MED LED just comes on.
5. Set the CCR to Step 3 and adjust the HIGH pot CCW until the HIGH LED just comes on.
6. Recheck the light at all current steps and verify that LEDs respond correctly at each step. Also verify by visual comparison that flashing intensity decreases when the CCR is switched from Step 3 to Step 2, and that it decreases further when the CCR is switched from Step 2 to Step 1.

Style 1 Current Regulator — Two Intensity Levels

For this style, the lighting system switches off when the CCR is at Step 1. It flashes at LOW intensity when the CCR is at Step 2, and at HIGH intensity when the CCR is at Step 3.

1. Turn the SENSE control fully CCW.
2. Turn the HIGH, MED, and LOW control fully CW.
3. Set the CCR to Step 2 and adjust the LOW control CCW until the LOW LED just comes on and the strobe light flashes in low intensity.
4. Set the CCR to Step 3 and adjust the HIGH control CCW until the HIGH LED just comes on.
5. Recheck the light at all current steps and verify that LEDs respond correctly at each step. Also verify by visual comparison that flashing intensity decreases when the CCR is switched from Step 3 to Step 2, and that the light switches off completely when the CCR is switched from Step 2 to Step 1.

Style 2 Current Regulator — Three Intensity Levels

For this style, the lighting system switches on when the CCR is at Step 1 and switches to progressively higher intensities as you switch the CCR to higher steps.

1. Turn the SENSE control fully CCW.
2. Turn the HIGH, MED, and LOW controls fully CW.
3. Set the CCR to Step 1 and adjust the LOW control CCW until the LOW LED just comes on.
4. Set the CCR to Step 3 and adjust the MED control CCW until the MED LED just comes on.
5. Set the CCR to Step 5 and adjust the HIGH control CCW until the HIGH LED just comes on.
6. Set the CCR to Step 4 and verify that the HIGH LED goes off. If not, you may need to adjust the HIGH control slightly CW until it does.
7. Set the CCR to Step 2 and verify the MED LED goes off.
8. Recheck the light at all current steps and verify that LEDs respond correctly at each step. Make trimming adjustments if necessary. Also verify by visual comparison that flashing intensity decreases when the CCR is switched from Step 5 to Step 4, and that it decreases further when the CCR is switched to Step 2.

Section 2 — Outline, Mounting, and Installation

Unpacking

Inspect shipping cartons for signs of damage. Check package contents against the packing list and inspect each item for visible damage. Damage claims should be reported promptly to the freight handler.

ATTENTION

Each light is packaged in its own shipping carton. The position at which the light is to be installed is marked on the carton and on an ID label on the outside of the power converter. Refer to *Figure 2-1* and *Figure 2-2* to identify positions.

Tools

The following hand tools are suggested for installation and maintenance:

- Phillips®-head screwdriver, #2
- 9- or 12-inch (# 2 - $\frac{3}{16}$ "), flat-blade screwdriver
- 9- or 12-inch (# 3 - $\frac{5}{16}$ "), flat-blade screwdriver
- Medium, slip joint pliers
- Set of combination wrenches
- 8-in. adjustable wrench
- Assorted nut-driver handles ($\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ")
- Universal terminal crimper
- Spanner wrench for 2-inch conduit locking nut
- Triplet™ Model 630-NA VOM, or equivalent analog volt-ohm meter

Access

WARNING

Read the warning on Page iii. Disconnect primary power before opening enclosures.

Power Converter

The power converter enclosure consists of a thermoplastic cover attached to an aluminum base. Wing-handled latches secure the cover. The cover tilts open for access to the interior.

FH 400 Flashhead

Three screw-fastened plates secure the lens to its base. Remove these to access the interior of the flashhead.

FH 800 Flashhead

Three screws fasten the bezel, which holds the flashtube in place. Remove these to access the flashtube or the interior.

Outline and Mounting

Each lighting unit consists of a power converter and a flashhead, mounted as separate units or comounted as a single unit. Frangible mounting couplings are available from FTCA. Use the outline and mounting dimensions shown in Figures 2-3 to 2-8.

Separately Mounted Power Converter: Mounting and outline is shown in *Figure 2-3*. The base plate has mounting holes for two 2-inch threaded pipes.

Separately Mounted Flashhead: Mounting and outline is shown in *Figure 2-4* and *Figure 2-5*. Separately mounted, the flashhead is typically installed on a pedestal or tower.

Comounted Assembly: *Figure 2-7* shows a comounted assembly, a common configuration for REIL applications. Mounting pipe details are similar to those in *Figure 2-3*, except that you must consider the increased overall height.

Installation

This manual may not contain all the information about installation wiring for your installation.

NOTE

If installation drawings prepared specifically for your site disagree with information provided in this manual, the site installation drawings should take precedence. Consult any site-specific installation wiring diagram supplied with your equipment.

FTCA wiring diagrams define only minimum requirements recommended for satisfactory equipment operation. *It is the responsibility of the installer to comply with all applicable electrical codes.*

Conduit and other distribution wiring details can be found on electrical installation diagrams provided by FTCA or others.

Figure 2-1 Typical REIL Configurations illustrates a typical REIL configuration. For the FTS 410, the two lights are functionally and physically interchangeable. The master light is designated as A. Although these lights flash simultaneously, lights for positions A and B should not be interchanged unless each one is re-aimed. The factory presents aiming for the position. Flashheads are typically comounted with power converters for REIL applications.

Figure 2-2 Typical ALS Configurations shows lights a typical RAILs. The five RAILs are labeled from 1 to 5 to identify their positions; the light with the lowest number is located farthest from the runway and is the first to flash. RAILs are typically configured by mounting power converters and flashheads as separate units. The two REILs are labeled A and B, with the master light as A.

Wiring

System power is supplied to the system controller. A contactor in the controller uses two conductors to distribute power to all power converters in the

system. Wire nuts connect line power wires to the controllers, and include those from the controllers to the power converters. These wires are connected at the power converter fuse terminals with screw connections. Typically, the wires are run through conduits and junction boxes and installed by electricians. *Figure 2-9* provides wiring guidelines for systems with internal controllers, while *Figure 2-10* provides guidelines for systems with external controllers. These figures are for reference only and may not exactly agree with details in your installation. *Always follow instructions in the Site Installation Diagram supplied with your equipment.*

CAUTION

This equipment is power phase sensitive. L1 and L2 must be wired to F1 and F2 in a consistent manner throughout the entire lighting system.

Note that the wiring diagrams define minimum requirements and may not comply with all applicable electrical codes. *It is the responsibility of the end user to comply with all prevailing electrical codes.*

Determine the wire gauge for power lines by considering service voltage, length of the wire run, and total load (number of lighting units). Use a value of 300 VA per lighting unit and do not permit the voltage drop caused by wire resistance to exceed 5% at any light. Internal or external control units add less than 25W to the total load. Also, use the value of 300 VA to determine the circuit breaker or the slow-acting fuse rating at the service disconnect box.

Wire control lines from the master power converter to all remaining power converters in the system by using two unshielded #14 AWG (or larger) conductors, *twisted together (6 turns per foot is recommended)*. **NOTE:** FTCA recommends 600 Volt insulation on all wires that interconnect the lighting system. FTCA recommends a counterpoise consisting of bare solid copper.

When you mount flashheads separately from power converters, wire each respective flashhead to TB2 in its corresponding power converter by

using a five-conductor cable (typically FTCA PN 6340).

Ground all power converter and separately-mounted flashhead cases to the site grounding system. FTCA provides a grounding lug on each power converter base. FTCA does not recommend connecting to the counterpoise for lightning protection.

Installation Checklist

Complete the following steps before applying power:

1. Inspect all equipment for damage.

2. Verify the received equipment against the packing list to ensure completeness.

3. Power Converter Mounting:

Position and mount each unit allowing adequate clearance for opening the covers. Also, use the following guidelines:

- Ensure that the case is mounted upright.
- Check hardware inside the case to ensure that the chassis mounting screws and nuts are tight.
- Ensure that the bottom of the case has clear drain holes.
- Ensure that no holes are punched or drilled on the top surface of the case.

- Ensure that air can flow around the case.
- Mount the power converter away from radio frequency interference (RFI).

4. Power Converter Wiring:

Examine the installation drawings and use the following guidelines:

- Check for proper incoming service voltage and current.
- Wire each unit according to the instructions.
- Ensure that all power converters are on the same line phase.
- Check all electrical connections for tightness.
- Check all terminal strip connections for tightness.
- Ground the power converter to the site grounding system.

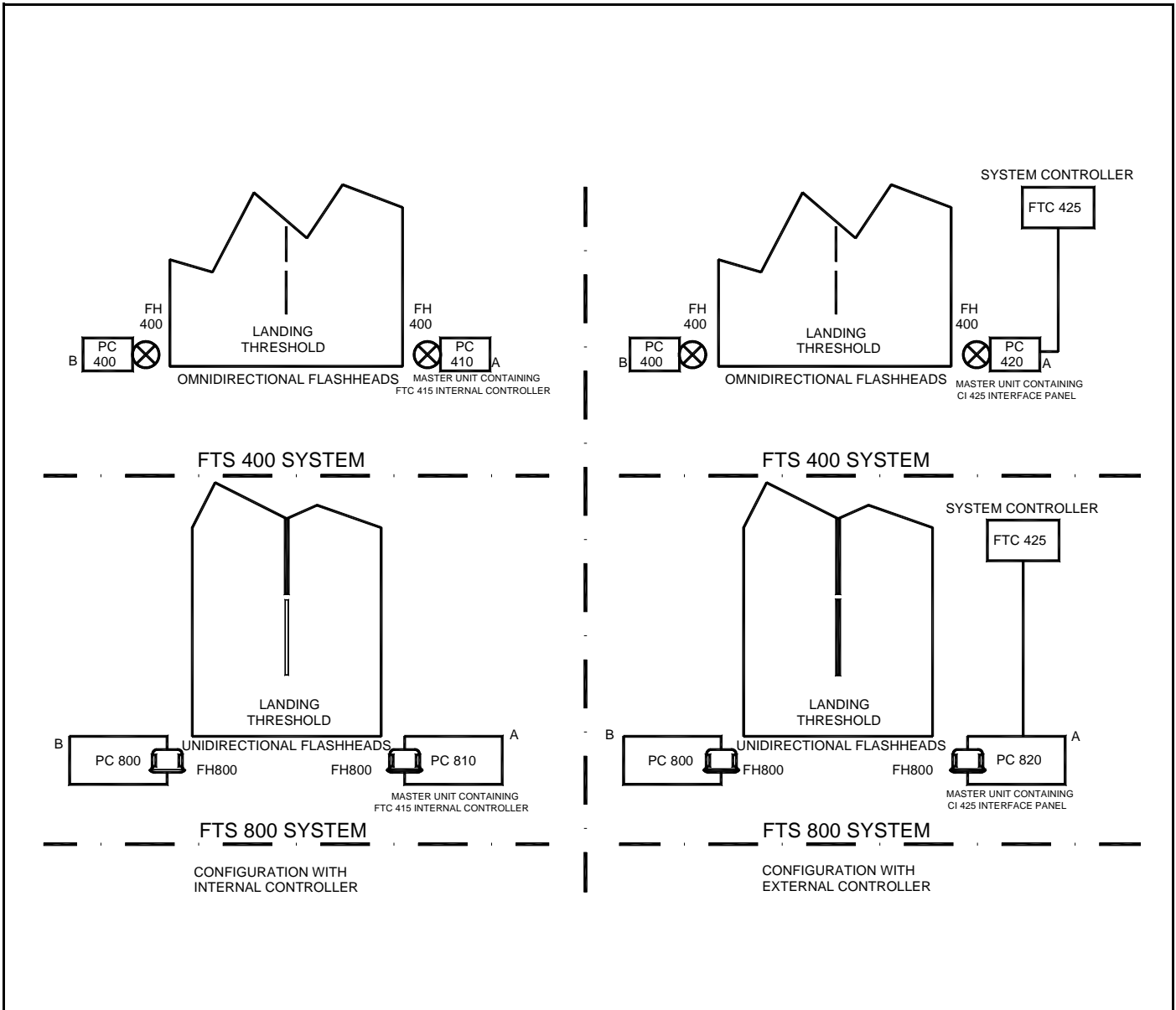
5. Flashhead Mounting:

- Check the aim of the flashhead.

6. Flashhead Wiring:

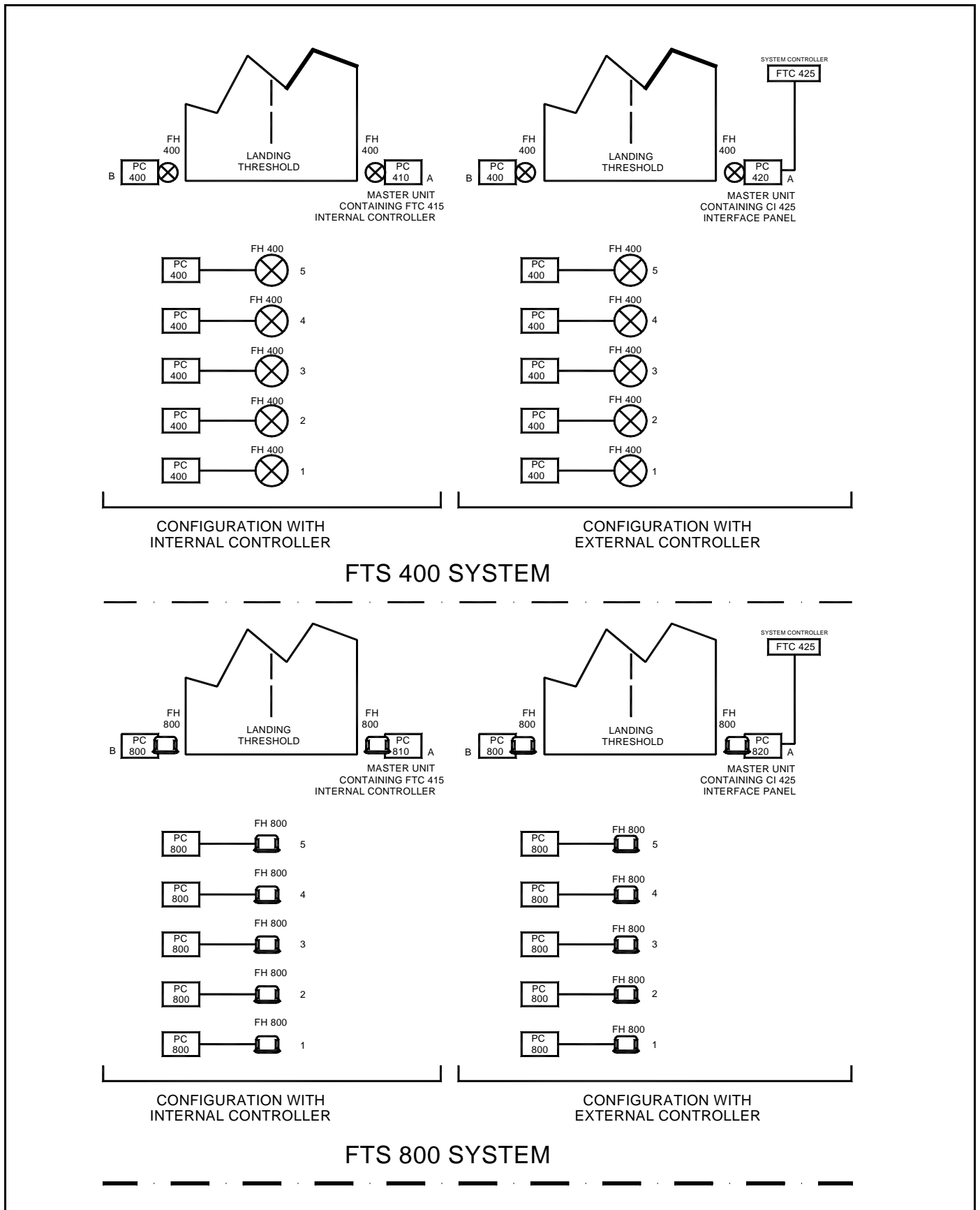
- Ground the flashhead if not comounted.
- Check the wiring of the flashhead cable to the flashhead.

After completing all the steps listed above, turn on the power and perform an operational check-out from procedures in Section 3 of this manual.



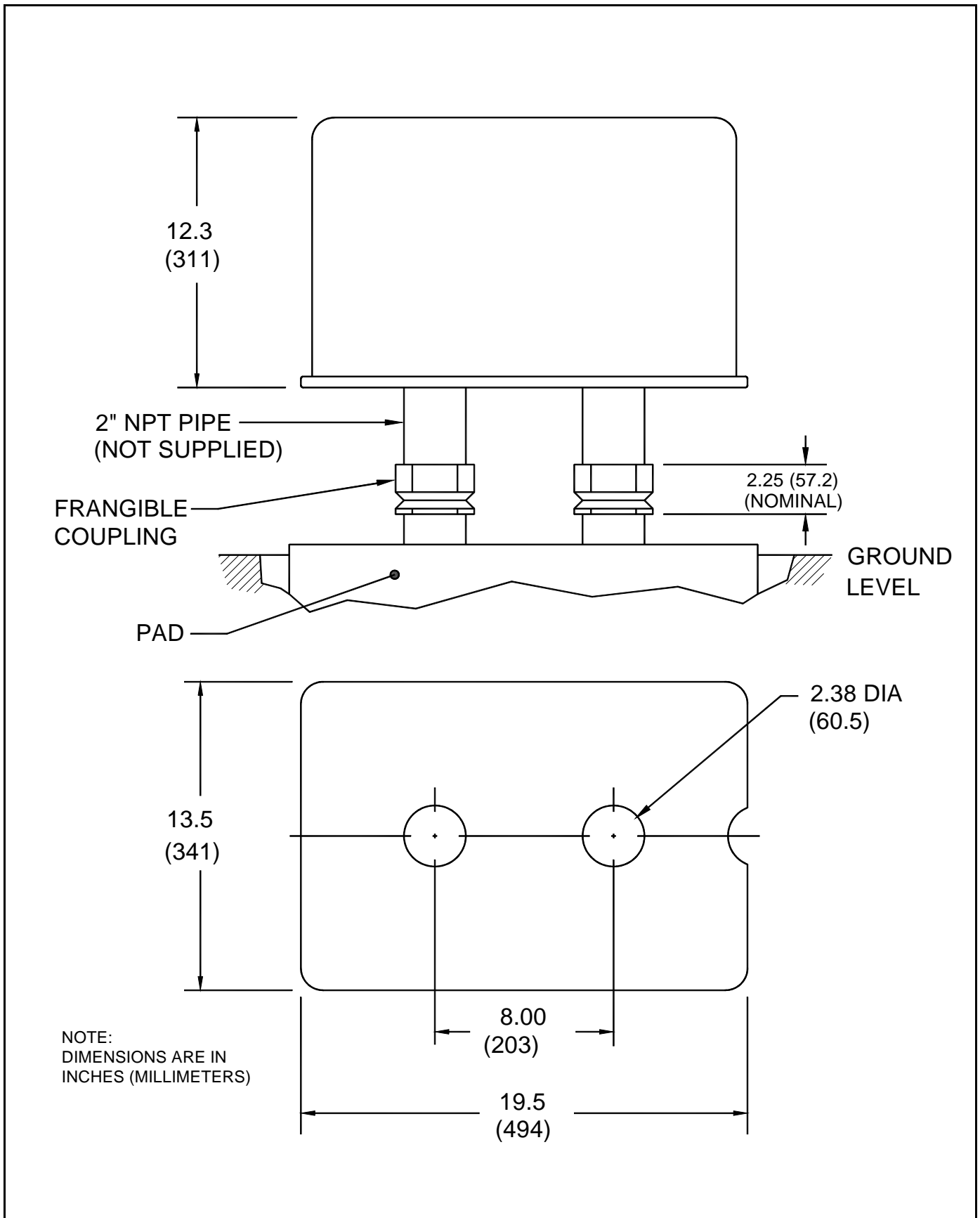
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Figure 2-1 Typical REIL Configurations



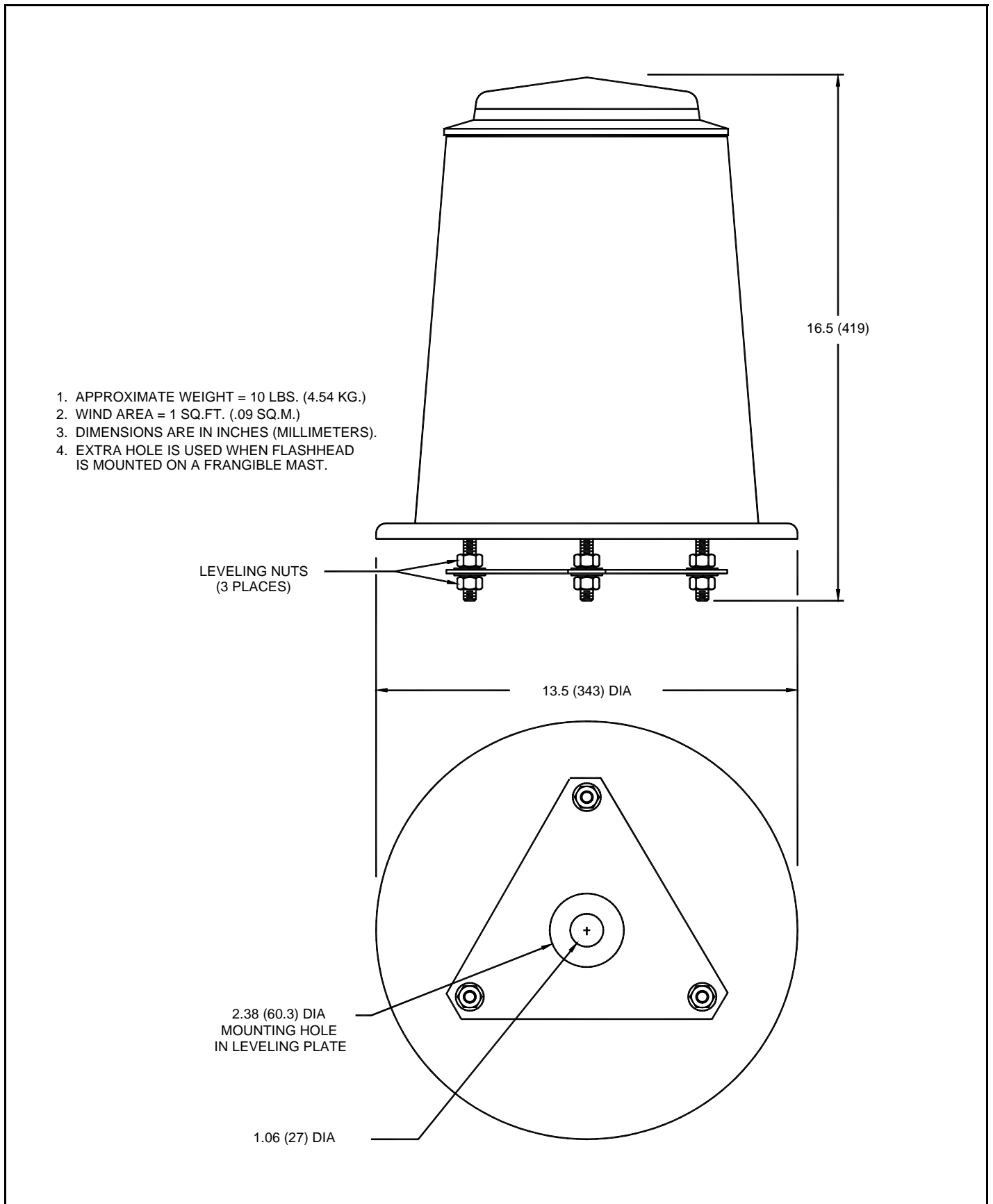
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Figure 2-2 Typical ALS Configurations



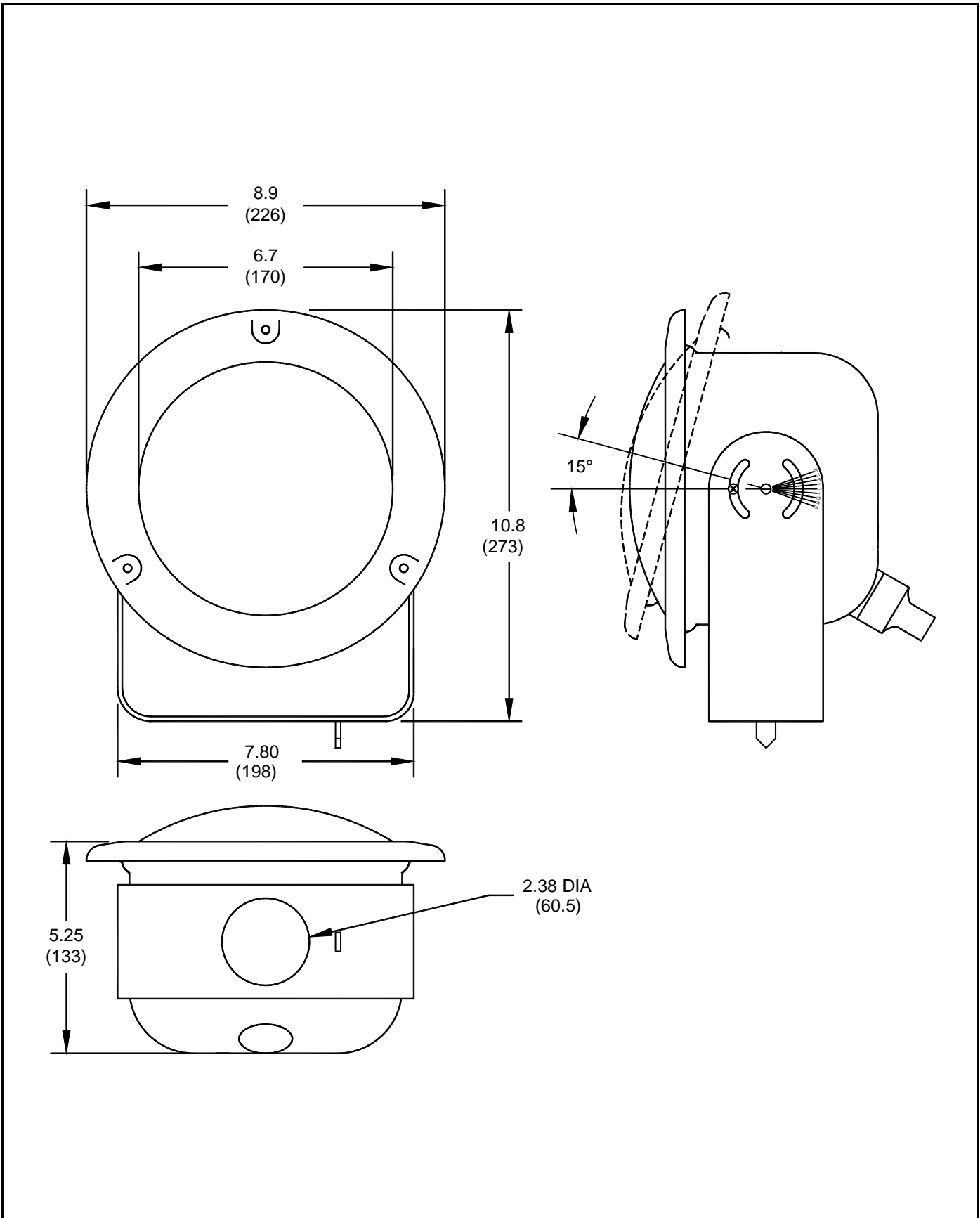
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Figure 2-3 PC 400-2 or PC 800-2 Power Converter Mounting and Outline



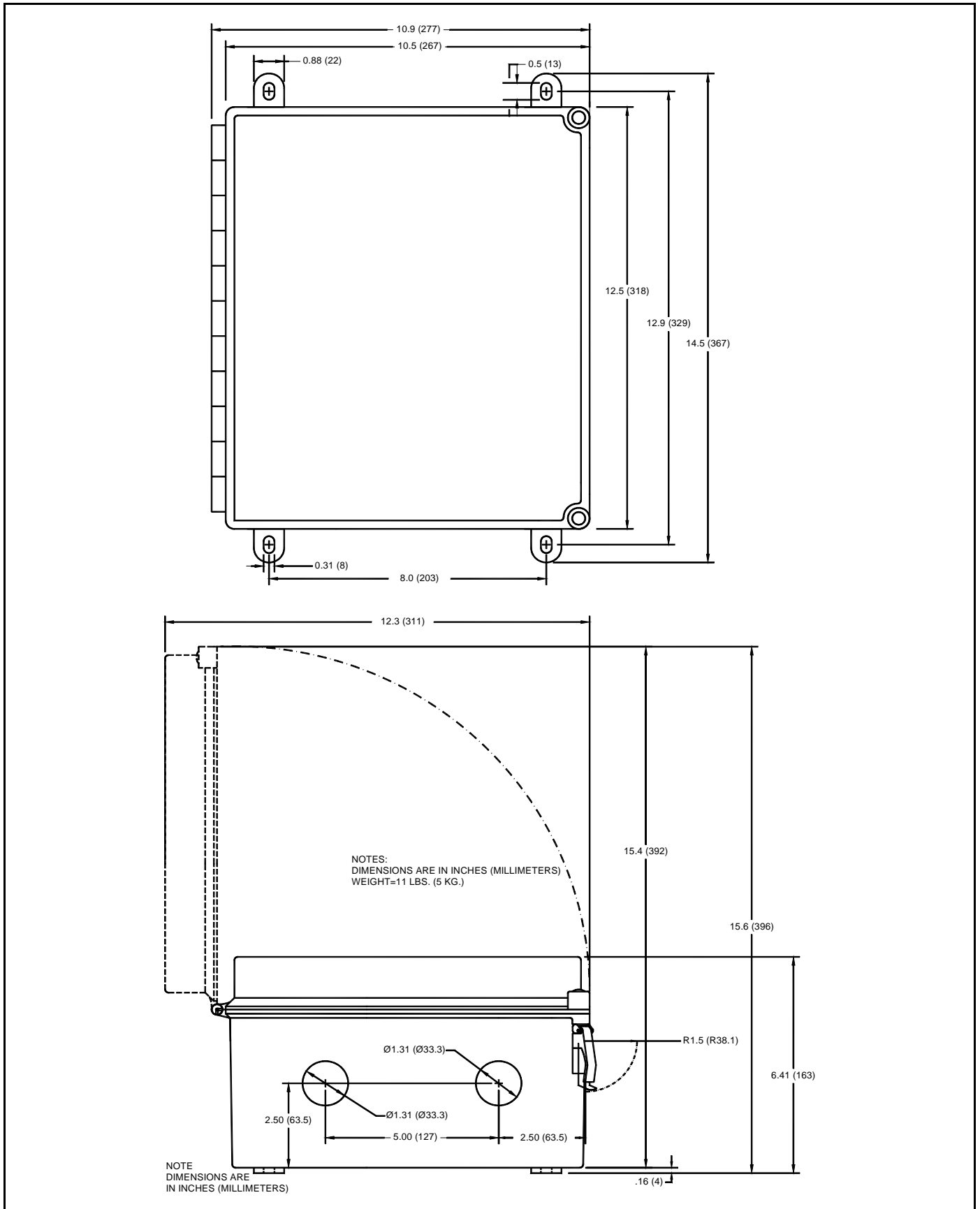
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Figure 2-4 FH 400 Flashhead Mounting and Outline



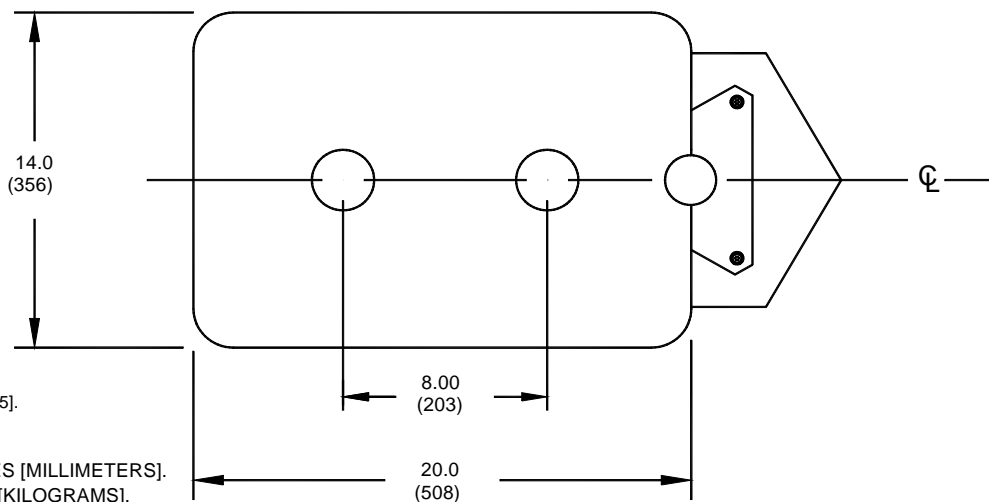
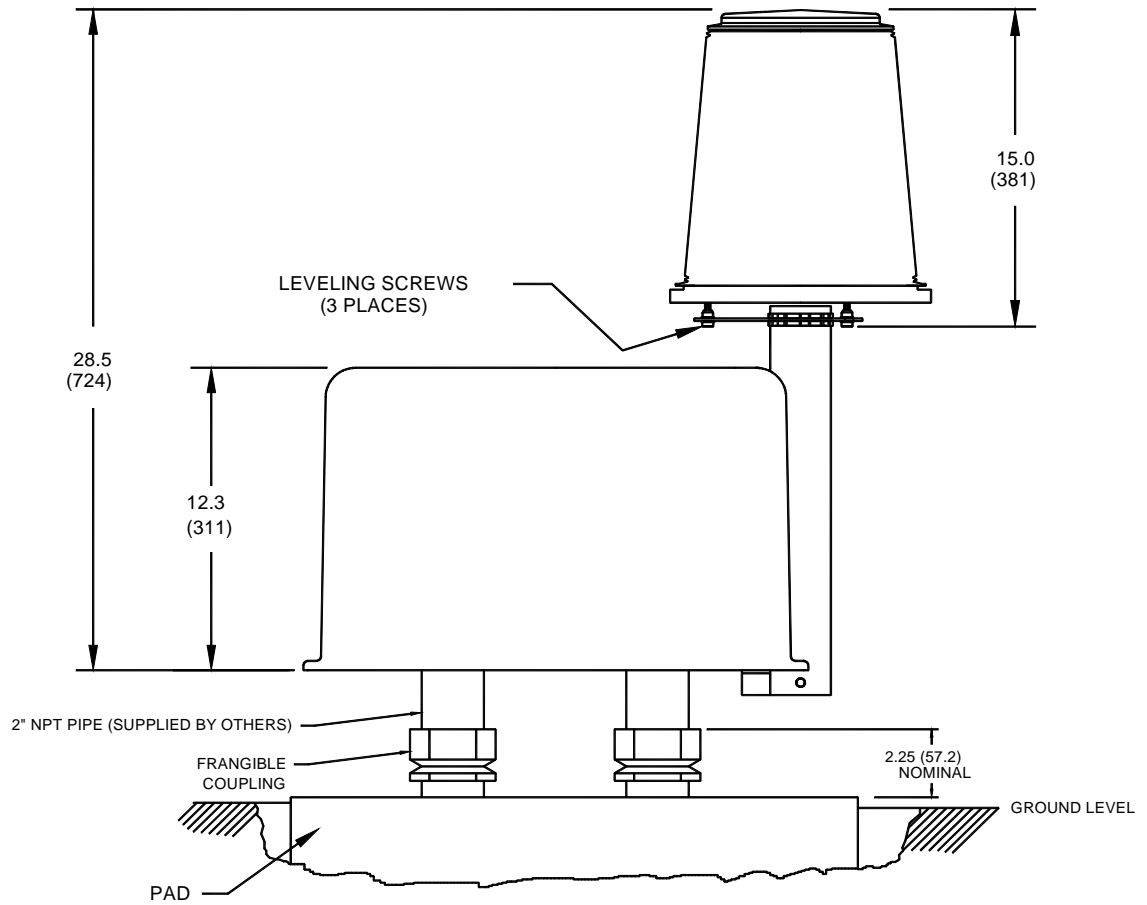
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Figure 2-5 FH 800 Flashhead Mounting and Outline



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Figure 2-6 FTC 425 System Controller and FTC 435 Series Controller Mounting and Outline



NOTES:

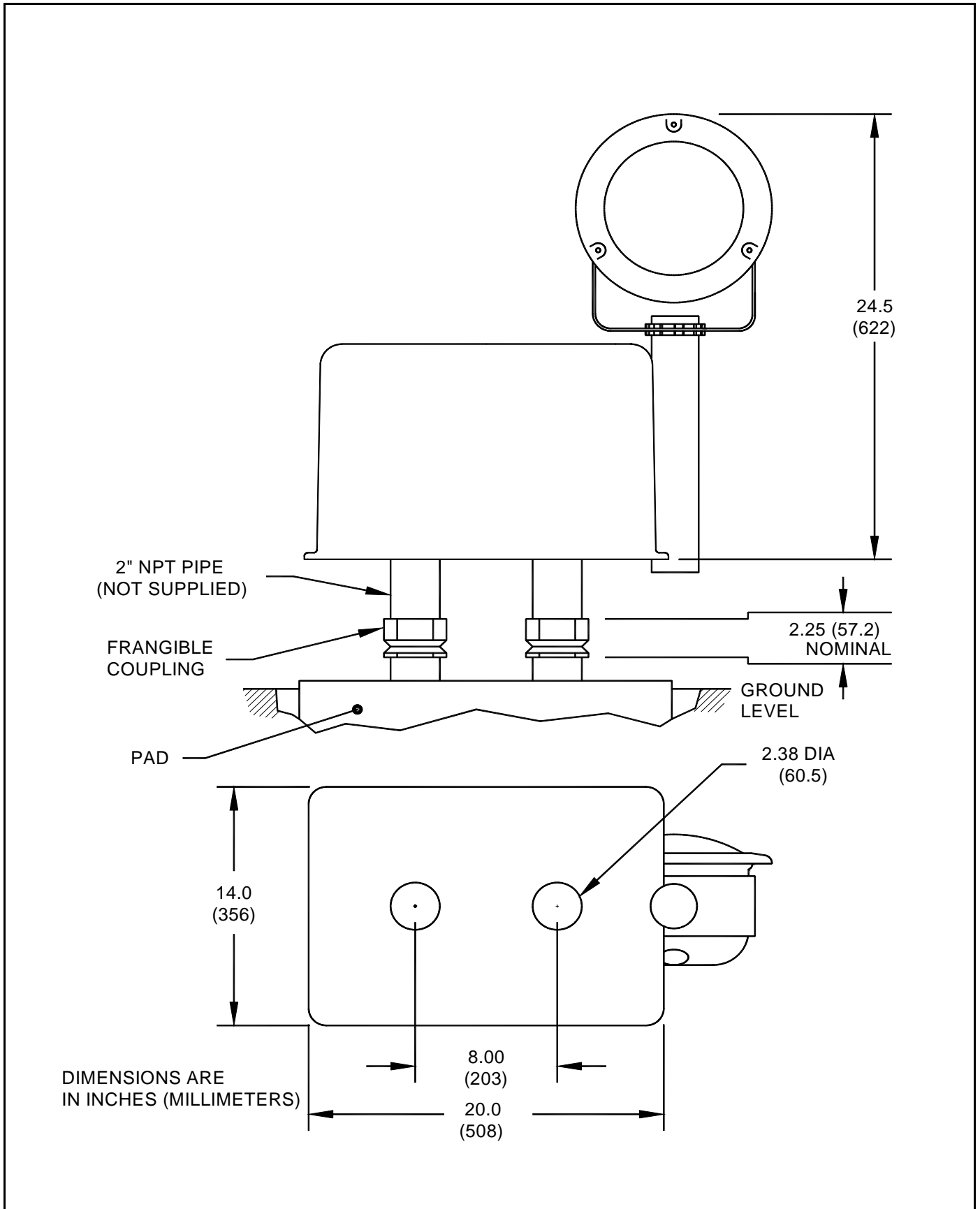
1.0 WEIGHT

- 1.1 POWER CONVERTER = 21 [9.5].
- 1.2 FLASHHEAD = 8 [3.6].

**2.0 DIMENSIONS ARE IN INCHES [MILLIMETERS].
WEIGHTS ARE IN POUNDS [KILOGRAMS].**

81000027

Figure 2-7 PC 400 and FH 400 Comounted Unit Mounting and Outline



81000028

Figure 2-8 PC 800 and FH 800 Comounted Unit Mounting and Outline

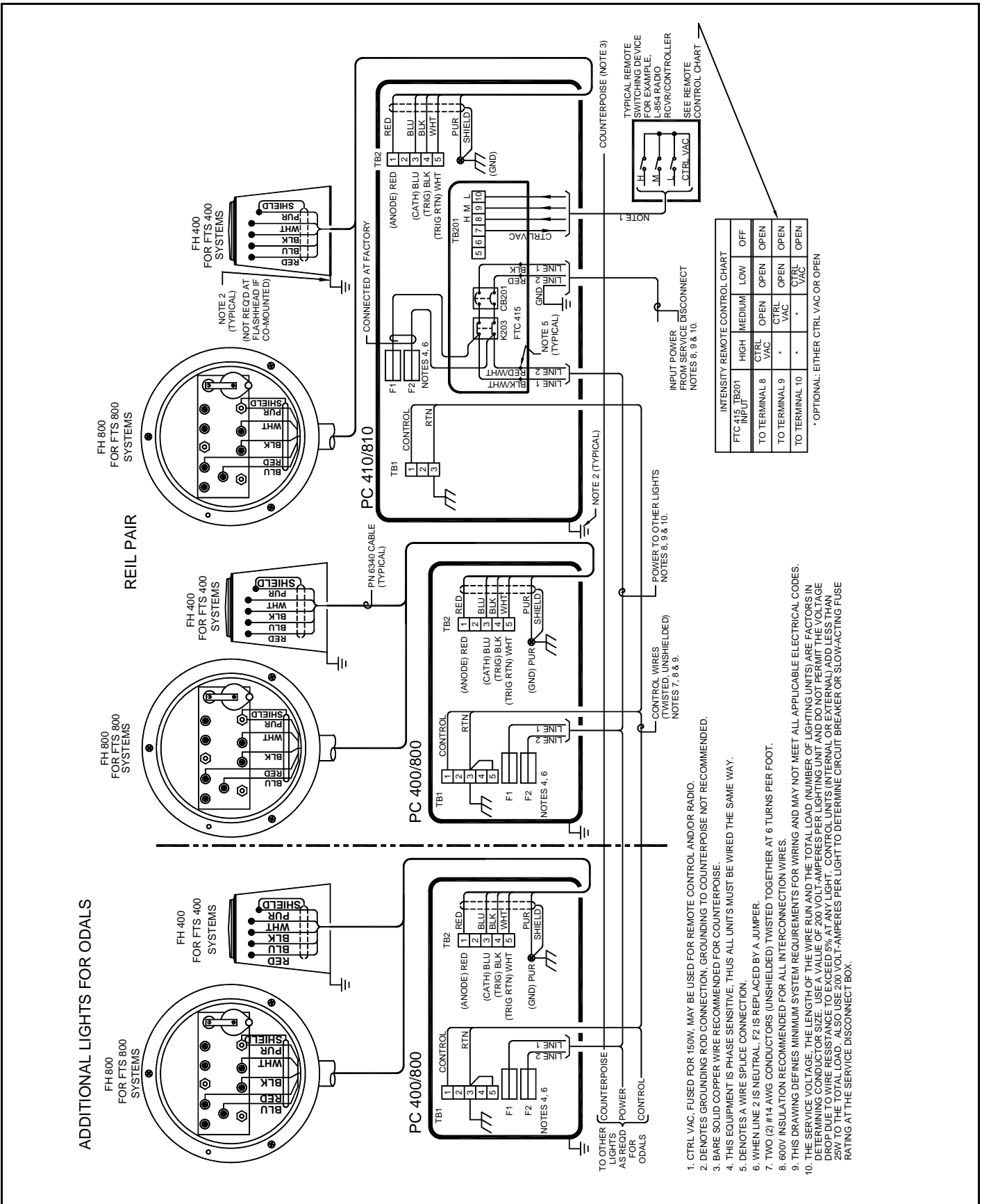


Figure 2-9 Typical Wiring for FTS 410 or FTS 810 System

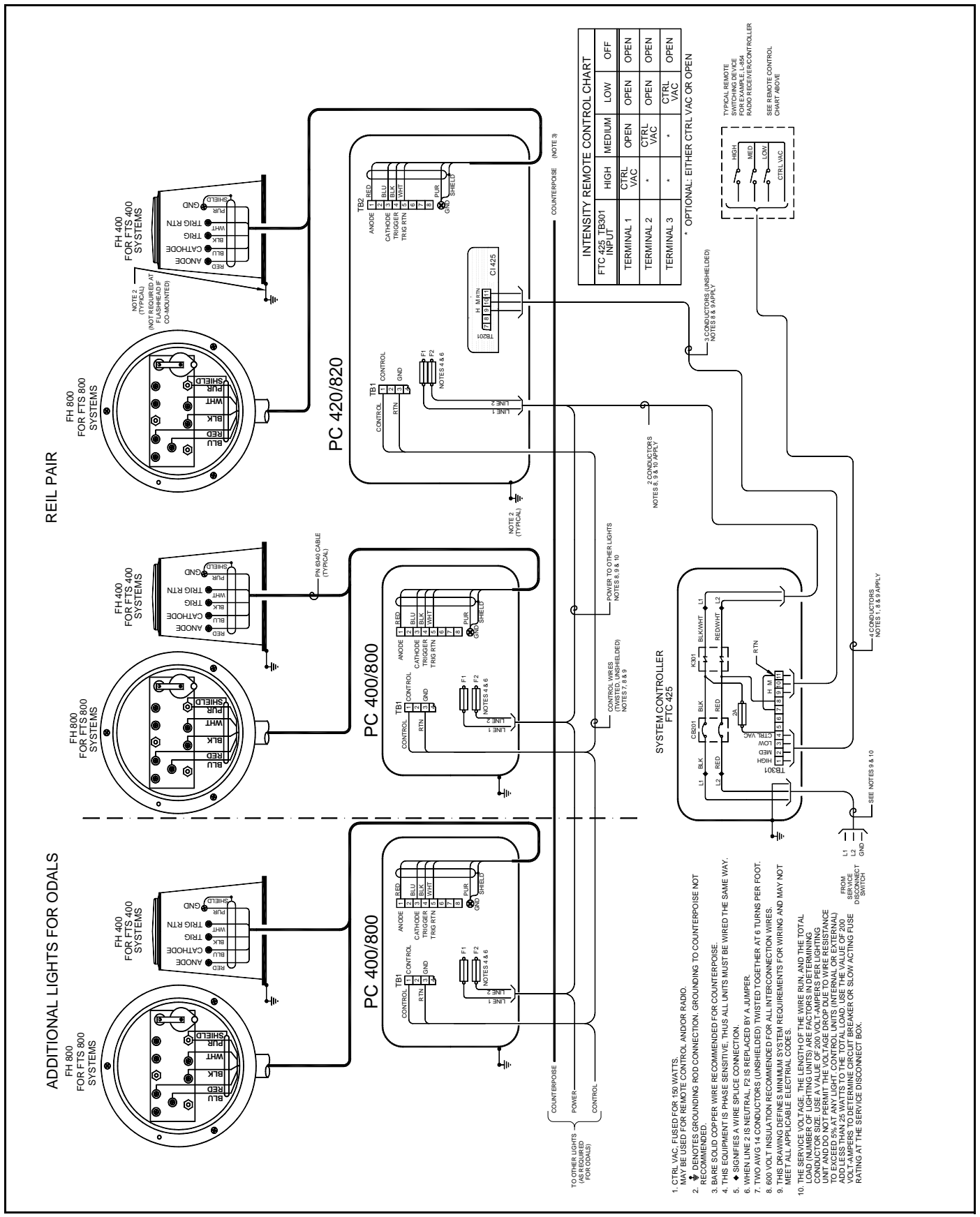
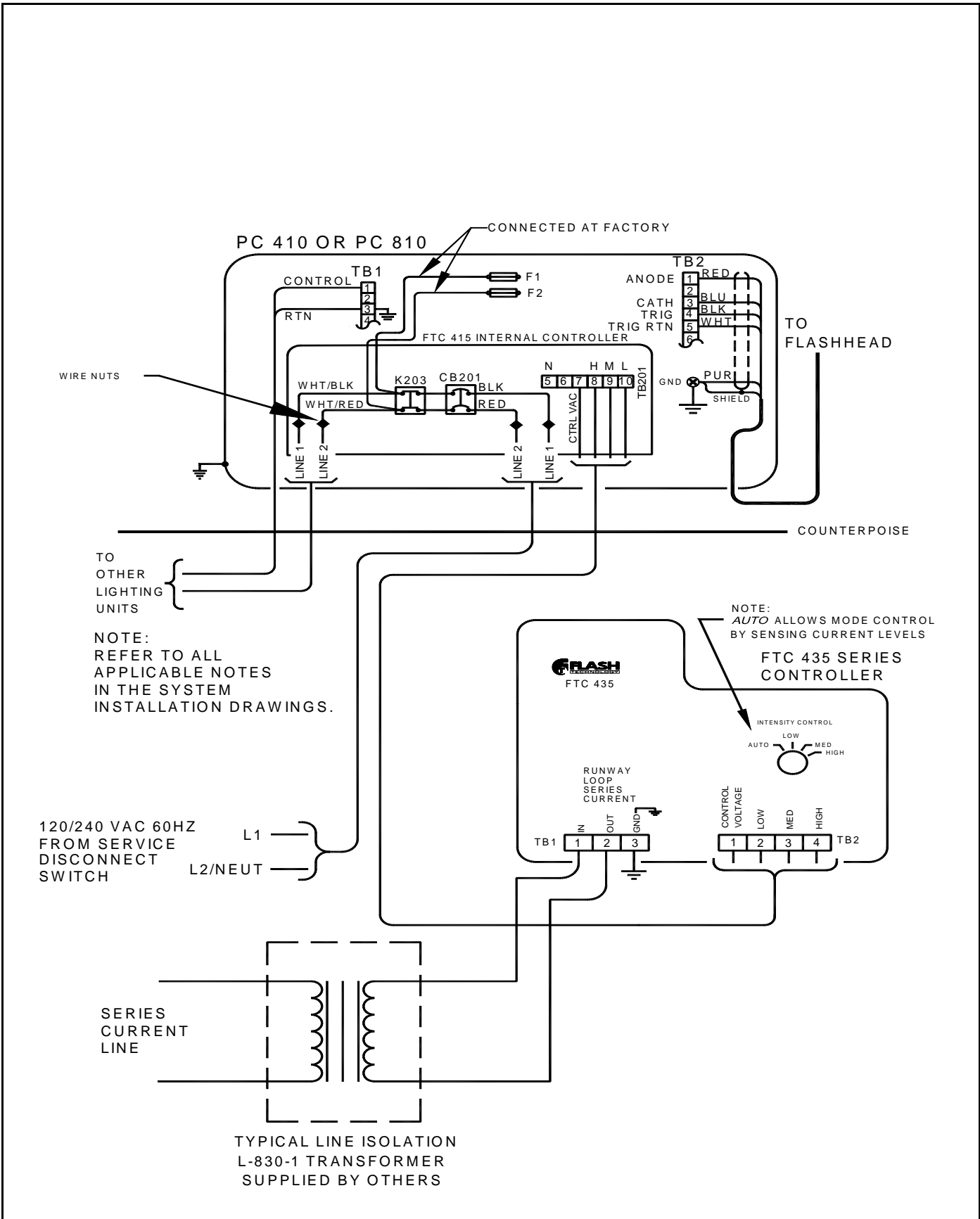
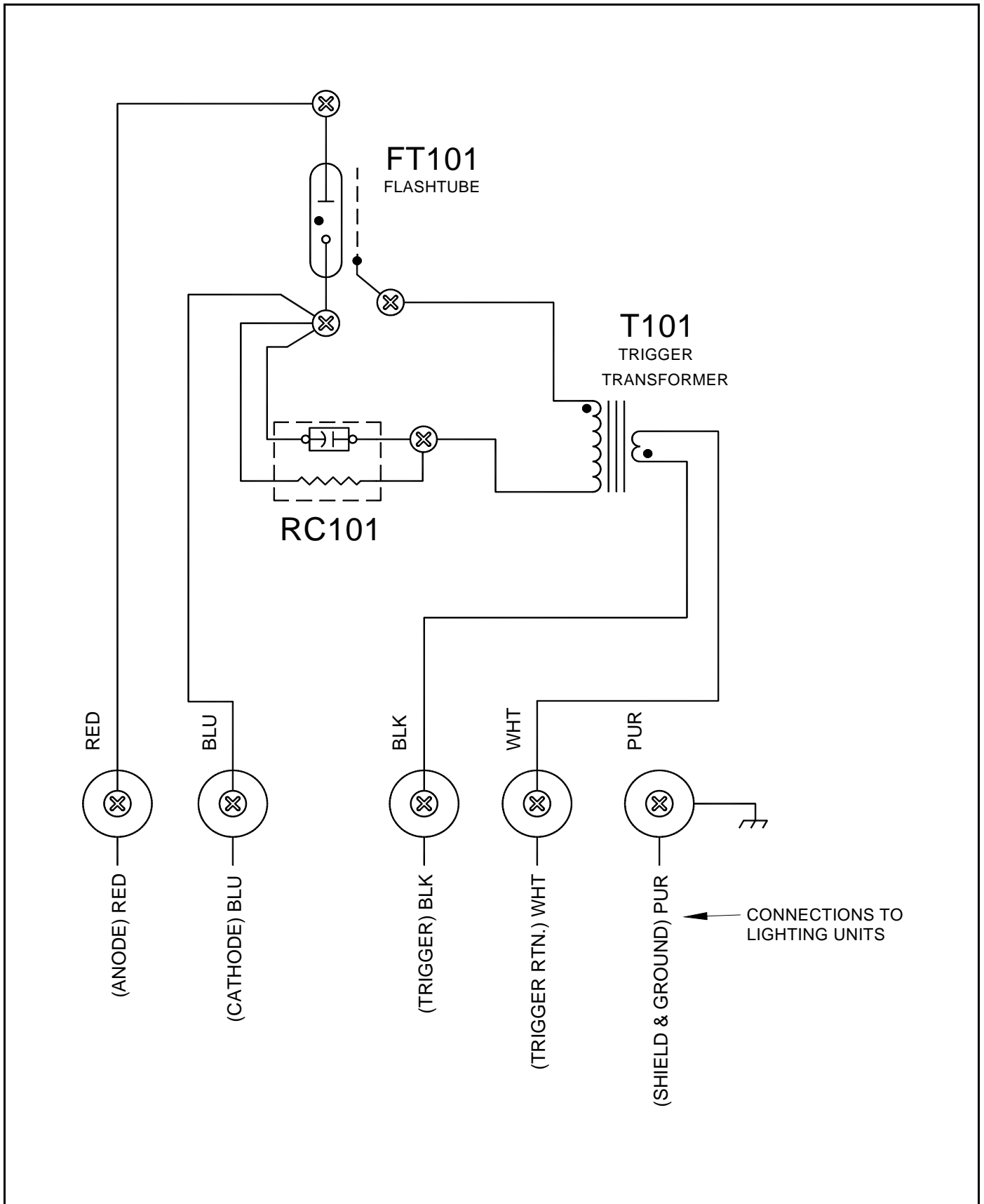


Figure 2-10 Typical Wiring for FTS 420 or FTS 820 Systems



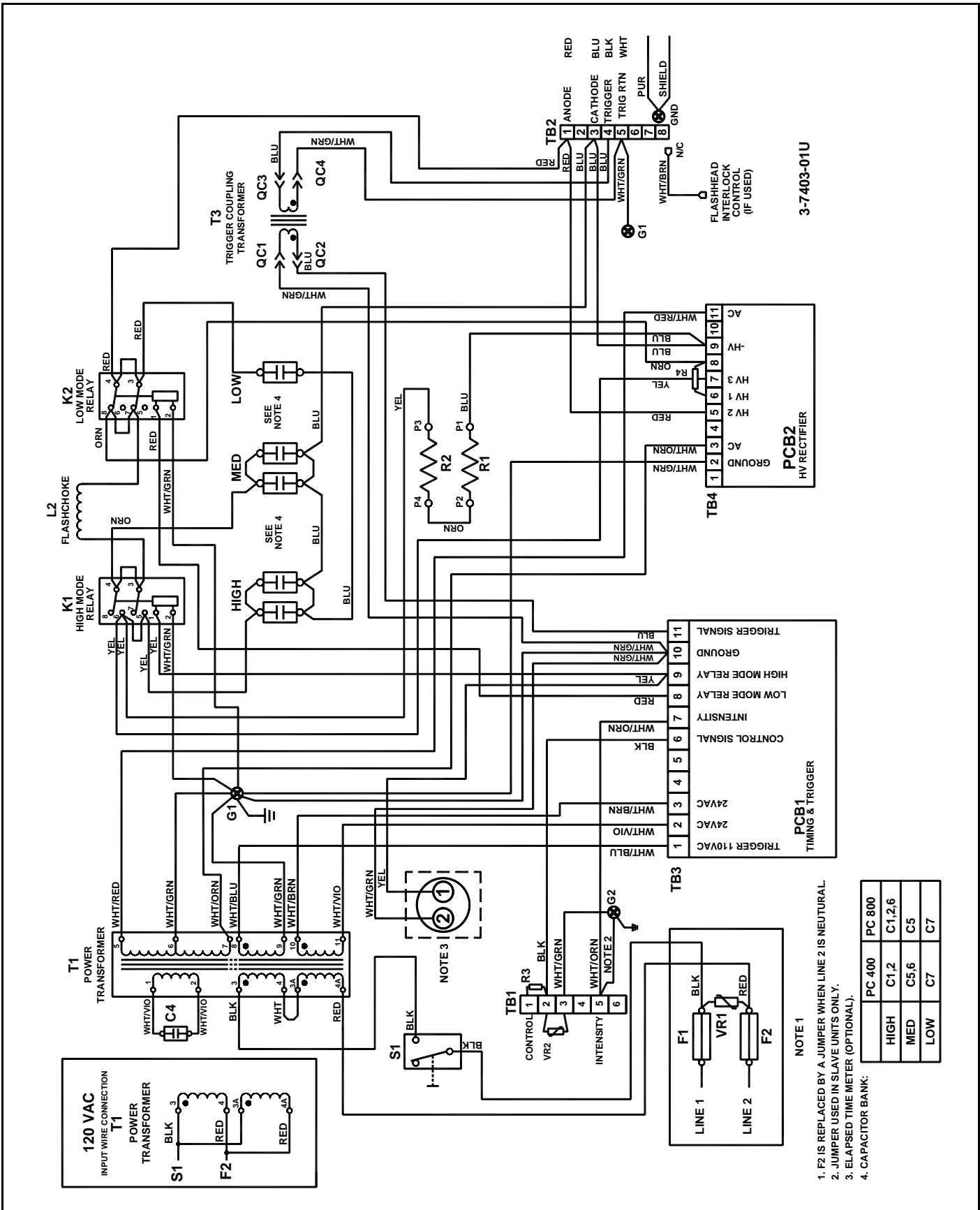
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Figure 2-11 Typical Wiring for FTS 410 or FTS 810 with FTC 435 Controller



810000212

Figure 2-12 FH 400 or FH 800 Internal Wiring



1. F2 IS REPLACED BY A JUMPER WHEN LINE 2 IS NEUTRAL.
2. JUMPER USED IN SLAVE UNITS ONLY.
3. ELAPSED TIME METER (OPTIONAL).
4. CAPACITOR BANK:

PC 400	PC 800
HIGH	C1,2,6
MED	C5,6
LOW	C7

Figure 2-13 PC 400 & PC 800 Power Converter Internal Wiring

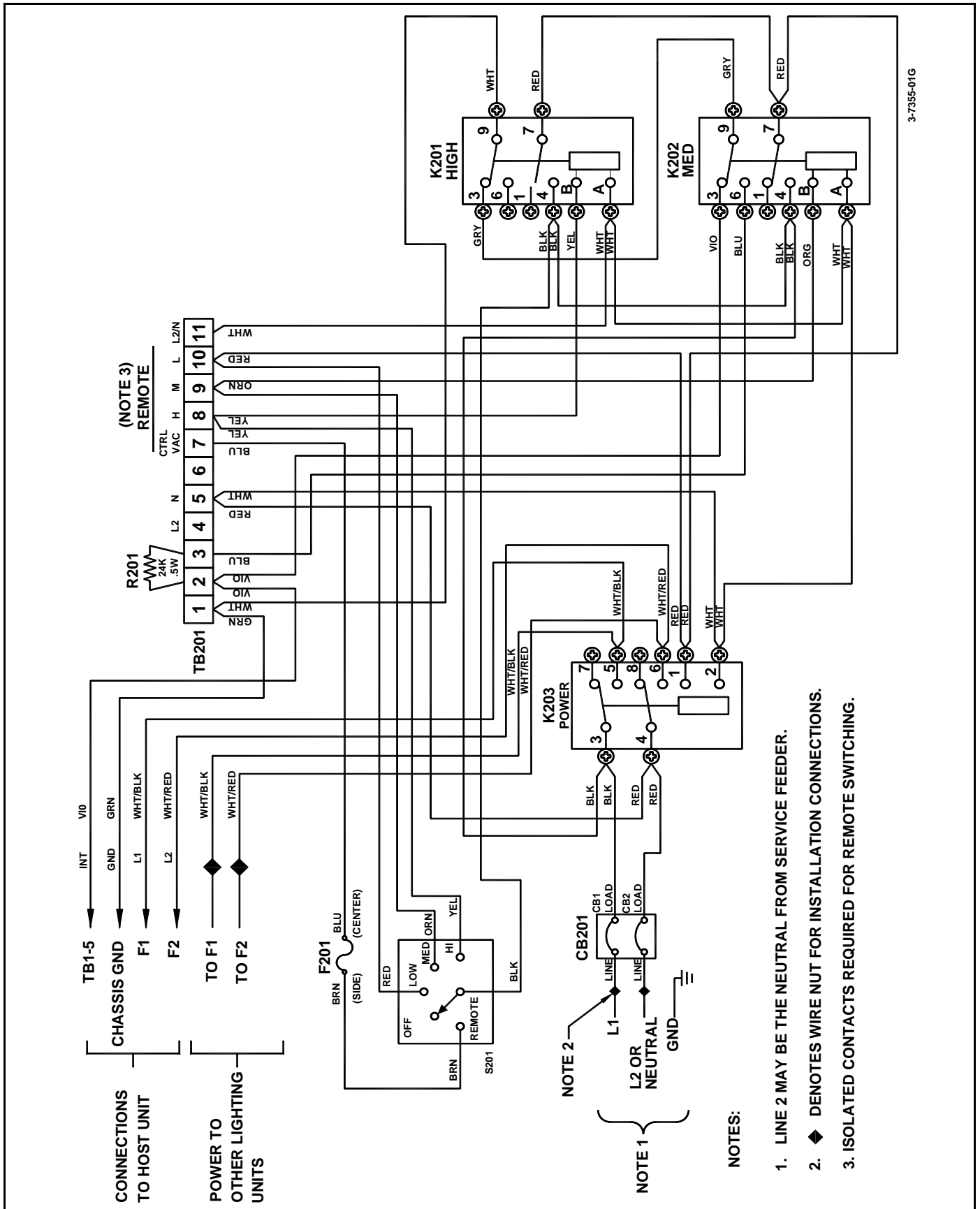


Figure 2-14 FTC 415 Controller Internal Wiring

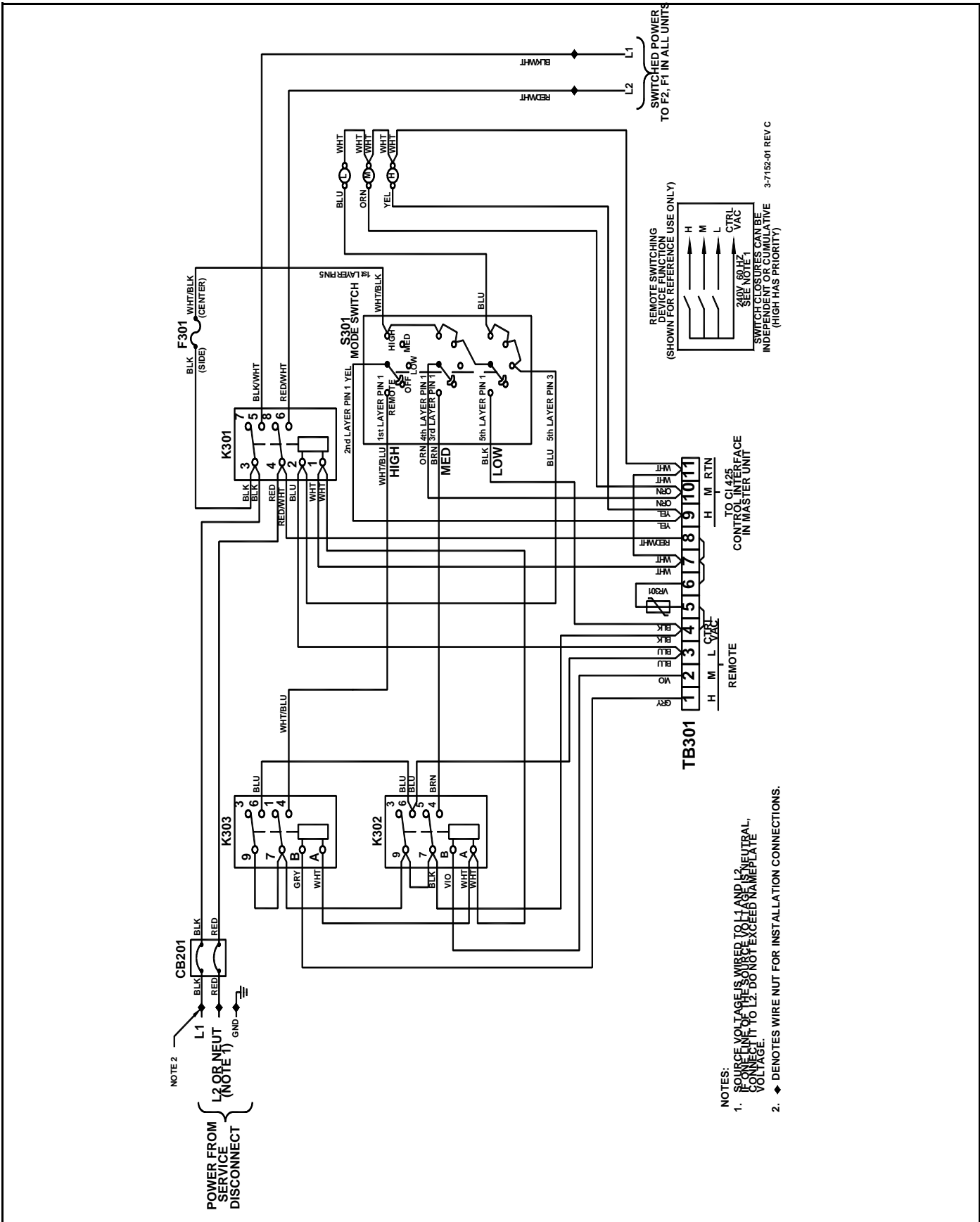


Figure 2-15 FTC 425 System Controller Internal Wiring

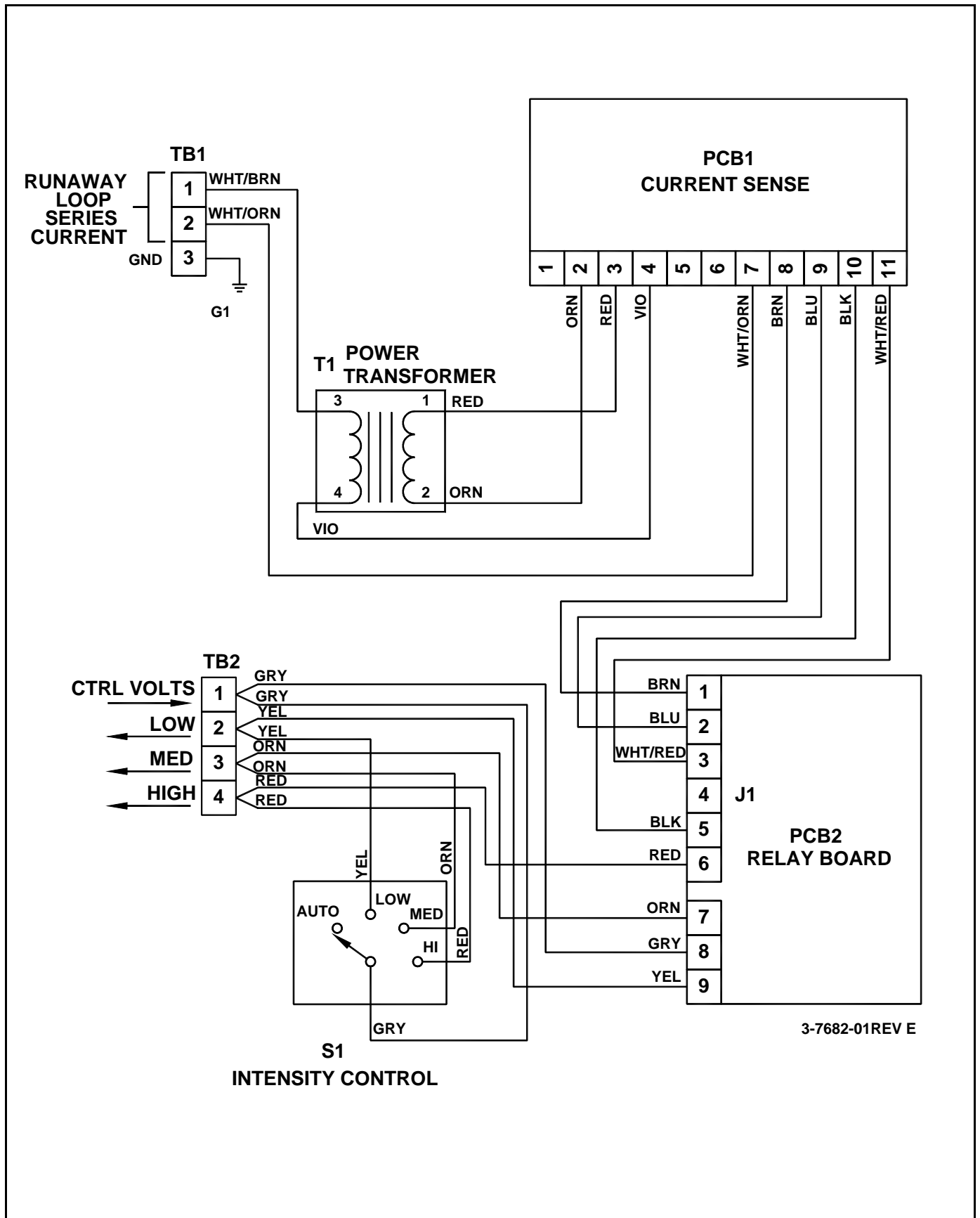


Figure 2-16 FTC 435 Series Controller Internal Wiring

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Section 3 — Maintenance and Troubleshooting

Safety

WARNING

Before proceeding—read warning on Page iii.

Work safely, as follows:

1. Remove rings and watches before opening the equipment.
2. Shut off the equipment.
3. Remove the component or connect the test instruments.
4. Replace the component.
5. Turn on the power and test the system.
6. Turn off the power and disconnect the test equipment.

Preventive Maintenance

Carry out the following inspection and cleaning procedures at least once a year:

1. Verify that moisture has not accidentally entered the equipment through gaskets or seals, or collected inside as condensation.
2. Verify that all drain holes are clear.
3. Check terminal blocks and relays for evidence of corrosion and electrical arcing. Clean or replace any component that shows evidence of high-voltage damage.
4. Check flashtube connections for signs of pitting or arcing. Verify that anode and cathode connections are firmly tightened.
5. Check all electrical connections for tightness and verify the absence of corrosion or electrical arcing.
6. Clean the outside surface of the FH 800 glass with liquid detergent and water. Wipe it gently with a soft cloth.
7. Clean the inside surface of the FH 400 lens with an FTCA-approved professional plastic

cleaner. Wipe the lens with cheesecloth only. *Do not use regular cloth or paper towels.* A lens cleaning kit, Part Number 8630801, is available from FTCA. Contact Customer Service at 1-800-821-5825.

Storage

No special considerations are required for long-term storage of any major assembly, such as the power converter or flashhead, or any internal component. Circuit boards, when not installed in the equipment, should be kept in antistatic bags or containers.

Diagnostic Testing

You can benefit by observing the behavior of the system as a whole and each lighting unit in particular when carrying out these test procedures; the observations will be useful for troubleshooting.

NOTE

This equipment uses a method of master/slave control that enhances its operation as a system. This type of control can sometimes cause misleading symptoms if one of the lighting units malfunctions. Thus, it may be necessary to disconnect the interconnecting control wire and to verify the operation of each lighting unit independently to pinpoint the cause of a problem.

Control Signal Evaluation

Refer to *Figure 2-1*. Note that, for each power converter, a *control line* and its return line are connected to TB1-1 and TB1-3 respectively. The synchronization signal on this line is a pulse. Therefore, it is difficult to evaluate with a meter. *Evaluating the control signal can be performed with a digital voltmeter that has an averaging function. Or, you can use an analog volt-ohmmeter*

such as the Triplet Model 630 set on the 3-volt scale. With either meter, the pulses that may be present on the line produce only momentary indications.

However, to be aware of how your particular meter responds to these signals, use the following information to evaluate the response:

- The *low-intensity* pulse is approximately 16 ms in duration
- The *medium-intensity* pulse is 33 ms in duration
- The *high-intensity* pulse is 66 ms in duration

The longer pulse deflects the needle more than the shorter pulse on an analog meter, or the longer pulse reads higher than the shorter pulse on a digital meter with an averaging function. Observe these signals with your meter and record the meter readings for future reference.

For example, using the Triplet Model 630 set on the 3-volt scale (AC or DC), the high-intensity control pulse deflects the needle 70-80% of full scale, the medium-intensity control pulse deflects the needle 50%, and the low-intensity control pulse deflects the needle 20-30%. On an analog meter, the needle must return to zero between pulses. If it does not, signal interference may be occurring, as described next; or, your system may have RFI (radio frequency interference) problems as described in *Section RFI Problems*.

If the entire system flashes at the wrong intensity or exhibits any other abnormal flashing behavior affecting all the lighting units, a control signal problem is indicated. Although the problem could originate at the controller or at the master unit, it could also be caused by any of the slave units, because all lighting units communicate bidirectionally in this type of master/slave system. A problem of this type is isolated by disconnecting each lighting unit from the control wire and examining its behavior independently.

The following procedures describe how to isolate each control problem to a single lighting unit or to the control signal wire itself.

RFI Problems

The presence of radio frequency interference (RFI) can cause a light to flash intermittently, at the wrong rate, or at the wrong intensity. RFI can enter the light by *any* wire to or from the unit. For example:

- RFI on primary power wires could cause errors in flash rate and intensity.
- RFI on the *control* (master/slave) interconnecting wire could cause a light to switch intensity.
- Strong RFI could burn out circuit board components.

Though the circuits reject or bypass RFI, FTCA cannot guarantee complete immunity beforehand. After installation, it may be necessary to add external filters or use other methods to reduce RFI entering the equipment.

Control Line Interference

Electrical interference on the control line can introduce system control problems. This can occur if the line is open, shorted, or not a twisted pair. The condition of all units responding correctly to the master and slave checkout procedures described above, but not when the control wire is connected, indicates a control line problem. Sometimes, you can eliminate marginal interference by placing a 1000 ohm resistor between the control line wires at the master unit. Installing a shunt capacitor can also help, but never exceed a value of 0.01 microfarads.

The control line has a ground return to interconnect the unit. Chassis ground is the reference.

Power Phasing

Input power phasing must be consistent, as noted in *Section Wiring* on Page 2-2. If even one of the lights is phased differently, none of the lights will switch to low intensity. To isolate an out-of-phase light (or lights), set the system control selector to LOW. Turn off all lights except for the master unit (use interlock switches to accomplish this) and verify that the master flashes at low intensity. Now turn on the remaining lights one at a

time and observe the master unit as each one is turned on. If the master unit changes intensity as any of the slave units is turned on, reverse the input power phasing of that slave unit (interchange L1 and L2 at the fuse block). Continue this procedure with all the remaining lights.

Master Unit Checkout

The master unit contains an internal controller or a control interface panel. Carry out the following steps on the timing and trigger board.

1. Temporarily disconnect the input control wire from TB3-6 and the intensity control wire from TB3-7.
2. Apply power to the system and set the control switch to any mode *except* REMOTE or OFF.

Verify the following response:

- a. The LOW LED is not lit.
- b. The HIGH LED is lit.
- c. The SYNC LED blinks brightly.
- d. The TRIG neon lamp glows.
- e. The light flashes at *high* intensity.

3. Place a temporary jumper from TB3-7 to TB3-10 (or the chassis).

Verify the following responses:

- a. The LOW LED is lit.
- b. The HIGH LED is not lit.
- c. The SYNC LED blinks dimly.
- d. The TRIG neon lamp glows.
- e. The light flashes at LOW intensity.

4. Remove the jumper placed in step 3. Place temporary jumper from TB3-10 (or the chassis) to test point TP8 on the board. *Do not confuse TP8 on the board with terminal 8 on the terminal block* (please refer to *Figure 3-1*).

Verify the following responses:

- a. The HIGH LED is not lit.
- b. The LOW LED is not lit.
- c. The SYNC LED blinks.
- d. The TRIG neon lamp glows.
- e. The light flashes at MEDIUM intensity.

- f. Remove the jumper between TP8 and TB3-10 (or the chassis).

5. If *any* LED response in items A to C of steps 2, 3, and 4 above is not exactly as described replace the timing and trigger board. Replace relay K1 or K2 if LED responses are correct but the light flashes at the wrong intensity.
6. Reconnect the intensity control wire to TB3-7, while leaving the system control wire disconnected from TB3-6. Set the control switch to LOW and verify that responses are identical to those in step 3.
7. Set the control switch to MED and verify that responses are identical to those in step 4.
8. Set the control switch to HIGH and verify that responses are identical to those in step 2.
9. If *any LED response in steps 6 through 8 is not exactly as described, replace the controller or interface panel, or both.*
10. Before reconnecting the control wire at TB-6, observe the flash intensity of the other (slave) beacons in the system. They should all be flashing at LOW intensity. If not, there is a problem with one of the lighting units or in the system control wire itself.
11. Reconnect the control wire to TB-6. Repeat steps 6 through 8 and verify that all lights flash properly. If any response is not as described, proceed to verify the operation of each slave unit.

Slave Unit Checkout

A slave unit is one that does not contain an internal controller or control interface panel. Carry out the following steps on the timing and trigger board of any slave unit. Refer to *Figure 3-1*.

1. Temporarily disconnect the input control wire from TB3-6 and the intensity control wire from TB3-7.
2. Apply power to the system and at the master unit controller, set the control switch to any mode *except* REMOTE or OFF.

Verify the following responses at the slave unit:

- a. The LOW LED is not lit.
 - b. The HIGH LED is lit.
 - c. The SYNC LED blinks brightly.
 - d. The TRIG neon lamp glows.
 - e. The light flashes at HIGH intensity.
3. Placed a temporary jumper from TB3-10 (or the chassis) to test point TP8 on the board. Do not confuse TP8 on the board with Terminal 8 on the terminal block. (Please refer to *Figure 3-1*).

Verify the following responses:

- a. The HIGH LED is not lit.
 - b. The LOW LED is not lit.
 - c. The SYNC LED blinks.
 - d. The TRIG neon lamp flashes.
 - e. The light flashes at MEDIUM intensity.
4. Remove the jumper placed in step 3. Reconnect the intensity control wire removed from TB3-7.

Verify the following responses:

- a. The LOW LED is lit.
 - b. The HIGH LED is not lit.
 - c. The SYNC LED blinks brightly.
 - d. The TRIG neon lamp glows.
 - e. The light flashes at LOW intensity.
5. If any LED response in items 1 through 4 of steps 2, 3, and 4 above is not exactly as described, replace the timing and trigger board. Replace relay K1 or K2 if LED responses are correct but the light flashes at the wrong intensity.
6. Restore the input control wire to TB3-6.

Troubleshooting

Accurately observe the system's operating behavior. This often leads directly to the cause of a problem. The diagnostic procedures in this subsection are divided into the two following categories:

- System-level malfunctions, where all lighting units exhibit the same abnormal behavior
- Symptoms applying to one or more individual lighting units, but not to all of them

System Level Problems

Table 3-1 identifies symptoms affecting all lighting units in the same way. Use it to determine possible causes.

Individual Light Problems

Use *Table 3-2* to identify problems that apply to a particular lighting unit only and to determine possible causes.

The entries listed in *Table 3-2* are numbered in the order of their likely occurrence. For example, assume that one of the lights does not flash in any mode (low, medium, or high) and the high voltage (HV) indicators are not lit. However, mode relays operate and circuit board LEDs are lit, which indicates the presence of low voltage (LV). The symptom best describing this condition is No No No No Ok. This symptom has four causes listed in sequence. The HV Rectifier Board is the most likely and the first cause listed. The Power Transformer is the next likely cause and second one listed. In this way, the causes follow in the sequence of their likelihood of occurrence.

All neon lights out on the HV rectifier board indicates the absence of HV. All LED lights out on the timing and trigger board indicates the absence of LV.

After determining that the problem's cause is a specific component, refer to the procedure for testing the component in *Section Component Testing*. If the component is faulty, replace it according to the appropriate component replacement procedure in *Section Component Removal and Replacement*

Table 3-1 System-Level Troubleshooting

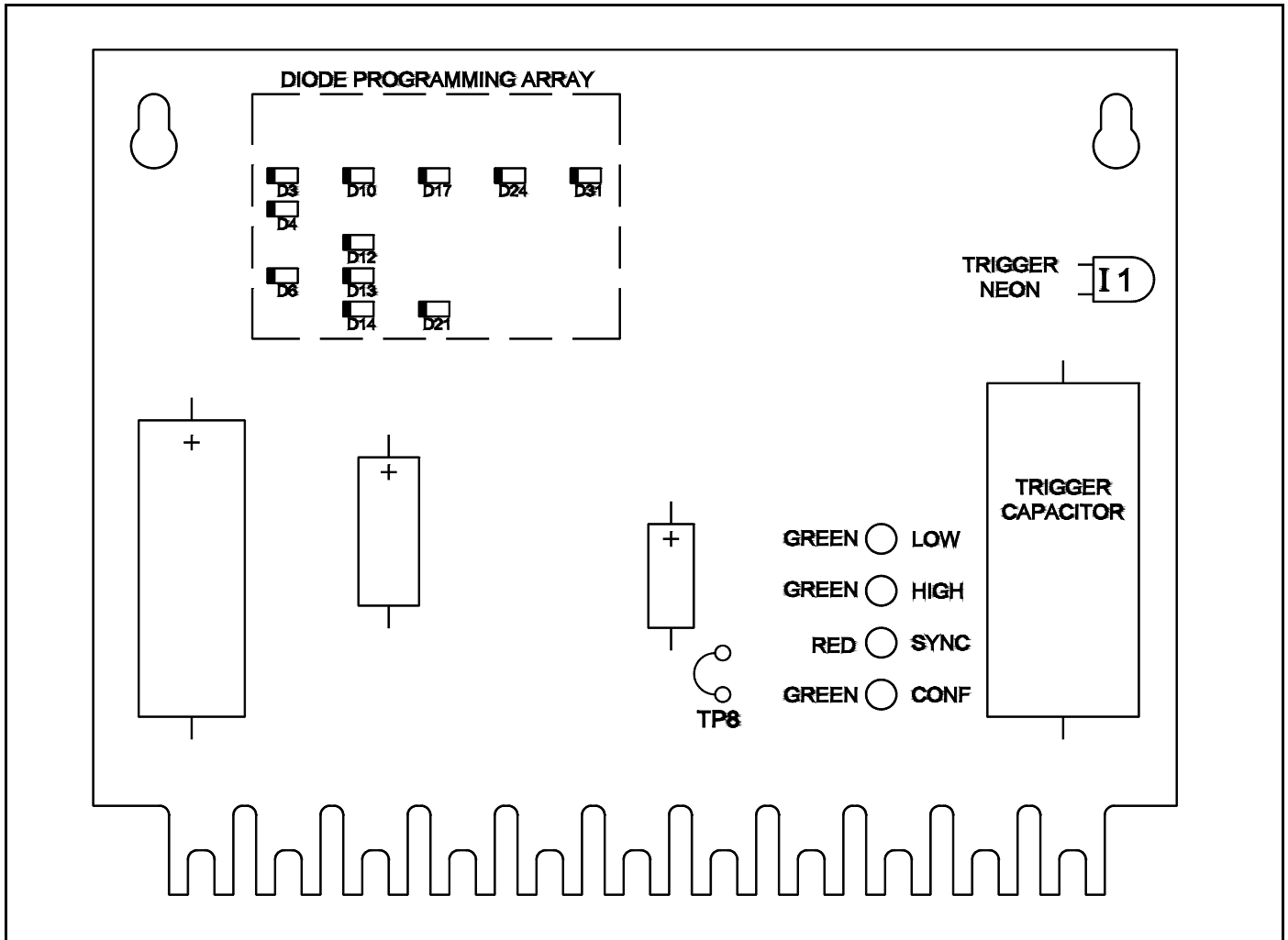
Flash Conditions			Component or Condition	Notes
High	Medium	Low		
No	No	No	Circuit Breaker CB201/202 or CB301/302	Note 2
No	No	No	Remote Control Fuse F201 or F301	Note 1, Note 2
OK	Bright	Bright	High Mode Relay K201 or Low Mode Relay K202	Note 3
Weak	Ok	Ok	High Mode Relay K201	Note 3
Weak	Weak	Ok	Low Mode Relay K202	Note 3
Ok	Ok	Bright	Phase error	Note 5
Erratic flashing in all modes			Control line not a twisted pair	Note 4

Notes:

1. Flashes properly when you set the master switch to low, medium, or high but does not flash when you set the switch to remote.
2. 300-series components are associated with an external (remote) control panel; 200-series components are associated with an internal control panel. A system may have either 200 series or 300 series components, but not both.
3. a.) Check relay contacts for dirt or corrosion.
b.) Check relay for normal energizing operation (verify that the relay pulls in).
4. A twist of 6 turns per foot is recommended.
5. Refer to *Section Power Phasing* on Page 3-2

Table 3-2 Lighting Unit Troubleshooting

Flash Conditions			Other Conditions		Component Or Condition	Notes
High	Medium	Low	HV	LV		
No	No	No	No	No	Primary Fuse F1, F2 Interlock Switch S1	
No	No	No	No	No	Primary Suppressor Asm. VR1 Power Transformer T1 Timing and Trigger Board PCB1	Fuses blow when replaced or circuit breaker trips
No	No	No	No	Ok	HV Rectifier Board PCB2 Power Transformer T1 Main Capacitor Bank C1, C2 Flashhead Cable	
No	No	No	Ok	No	Timing and Trigger Board PCB1 Power Transformer T1	
No	No	No	Ok	Ok	Flashtube FT101 HV Rectifier Board PCB2 Trigger Transformer T101 Power Transformer T1 Flashhead Cable Main Capacitor Bank C1, C2	
No	No	Ok	Ok	Ok	Main Capacitor Bank C1, C2 HV Rectifier Board PCB2	
Ok	Ok	No	Ok	Ok	Low Mode Capacitor C3 HV Rectifier Board PCB2 Low Mode Relay K2	
Weak	Weak	Ok	Ok	Ok	Low Mode Relay K2 Timing and Trigger Board PCB1	
Ok	Bright	Ok	Ok	Ok	HV Rectifier Board PCB2	
Skips	Ok	Ok	Ok	Ok	Tuning Capacitor C4	
Skips	Skips	Skips	Ok	Ok	Trigger Arcing Flashtube FT101 Trigger Transformer T101 Coupling Transformer T3	



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Figure 3-1 PCB1 Timing and Trigger Board Pictorial

Component Testing

The following procedures describe how to check most of the major electrical components. Always make resistance measurements with the power turned off. Voltage measurements require power to be on; however, perform all preliminary steps such as connecting test leads or circuit jumpers, or disconnecting existing circuit connections, with the power turned off and storage capacitors discharged.

Capacitors (C1, C2, C3)

Test capacitors with an ohmmeter capable of measuring one megohm or greater, using the procedure described following.

Resistance measured between the terminals of a fully discharged capacitor is initially zero and increases steadily with time if you leave the ohmmeter leads across the terminals. Eventually, an open circuit condition occurs. The time it takes for the complete transition from zero to maximum depends on the total amount of capacitance. A capacitor disconnected from other circuitry is defective if it does not exhibit this behavior. Manually discharge the capacitor before repeating this measurement. This procedure may not detect a failure that occurs at high voltage only. Please note that the final measured resistance across C1 is limited to 100K ohms unless you disconnect the safety bleed resistor R1.

Flashtube (FT101)

PERSONNEL HAZARD WARNING

NOTE

Protect yourself — always turn off the input (primary) power and wait for one minute for storage capacitors to drain their charge. Capacitors may be manually discharged by placing a resistance (25 Watts, 10,000 ohms or greater) between their terminals. Then check between the red and blue wires on TB2 with a voltmeter for any residual charge before touching any circuit element or component.

Do Not Depend on Interlocks

Never depend on interlocks alone to remove unsafe voltages. Always check circuits with a voltmeter. Under no circumstances remove or alter any safety interlock

A visual inspection tells you little about the working condition or performance of a flashtube. A darkened envelope does not necessarily mean the light output is unacceptable. Do not replace the flashtube until you rule out other causes, such as a lack of discharge potential or triggering pulses.

Relays (K1, K2)

A malfunctioning relay may have faulty contacts, a sticky mechanism, or a defective coil. You may determine the first two possibilities by inspection and by manually exercising the armature. Perform the following resistance measurement to confirm a defective coil:

1. Remove the PCB1.
2. Measure coil resistance between TB3-7 and the chassis to test Low Mode Relay K2.
3. Measure coil resistance between TB3-8 and the chassis to test High Mode Relay K1.

The measured coil resistance in either case should be approximately 290 ohms.

High Voltage Rectifier Board (PCB2)

Replace PCB2 with one known to be in good condition.

High Voltage Transformer (T1)

To test this transformer, first remove (PCB1) and (PCB2). Apply power to the unit and measure secondary winding voltages at the terminals indicated.

Table 3-3 High Voltage Transformer (T1) Voltages

Terminals	Voltage Range
TB4-3 to TB4-11	900-1050 volts AC*
TB3-1 to chassis	100-120 volts AC
TB3-2 to TB3-1	22-26 volts AC

* If this AC voltage is substantially below the specified minimum value, check tuning capacitor C4.

Trigger Coupling Transformer (T3)

Visually observe the transformer for damage. Check the transformer for open windings by measuring the primary and secondary windings with an ohmmeter. An open winding indicates infinite ohms on the ohmmeter. A normal winding should indicate less than 200 ohms.

Timing and Trigger Board (PCB1)

Replace this circuit board with one known to be in good condition. You may use temporarily a general purpose spare board, PN 2652318. It exercises all functions of the lighting unit but flashing does not occur in the correct sequence. The spare PN 2652318 board must be programmed as instructed in the Timing and Trigger Board replacement procedure following if it is to replace the original circuit board.

NOTE

The PN 2652318 board does not function normally until you program it for one of the lighting units. Snip out the diodes on the replacement board to match those in the board that you are replacing.

Bleed Resistor (R1)

The total measured resistance of the bleed circuit should be 85,000 ohms.

Interlock Switch (S1)

Try adjusting the switch bracket. The switch should clearly read zero ohms when it is closed and infinite ohms when it is open.

Component Removal and Replacement

This section contains instructions for removal and replacement of most major replaceable components. Refer to *Section 4* for parts lists and locations, and component location diagrams for assembly and disassembly. Refer to *Section 2* for installation and internal wiring. *Figure 2-12* shows a wiring diagram for the flashheads. Internal wiring for the power converters is shown in *Figure 2-13*.

High Voltage Transformer (T1)

Removal

1. Disconnect wires leading to the transformer
2. Remove four screws holding the transformer to the rear of the chassis and remove the transformer from the chassis.

Replacement

Reverse the removal procedure. Verify that wiring agrees with *Figure 2-13*.

Trigger Coupling Transformer (T3)

Removal

1. Disconnect the Faston connectors. Note the wire directions at the top of the primary and secondary coils.
2. Remove the two 4-40 x 2" phillips head screws holding the transformer assembly to the bracket.
3. Remove the transformer.

Replacement

1. Reinstall the windings in the directions noted in Step 1 of Removal. Ensure that the wires have the same orientation.
2. Reattach the electrical wires. Verify that wiring agrees with *Figure 2-13*.

Timing and Trigger Board (PCB1)

Removal

1. Loosen, but do not remove, all eleven screws holding the circuit board to TB3.
2. Loosen, but do not remove, the screws at the top that hold the board to the front of the chassis and lift the board from TB3.

Replacement

1. If you are replacing the PCB1 with a spare (PN 2652318), you must program the spare to initiate flashing in the proper sequence. Program it by removing diodes from PCB1 for a specific lighting position by snipping out the appropriate diodes to match exactly those that are removed in the board you are replacing. Do not program the spare board until you are certain that you want to use it in a particular position.
2. Perform steps 1 and 2 of the Removal procedure in the reverse order.

HV Rectifier Board (PCB2)

Removal

1. Loosen, but do not remove, all eleven screws holding the circuit board to TB4.
2. Loosen, but do not remove, the screws at the top that hold the board to the front of the chassis and lift the board from TB4.

Replacement

Reverse the Removal procedure.

Capacitors

Removal

1. Disconnect the wires leading to the capacitors.
2. Remove the hold-down screws. Lift capacitors from their receiving holes and away from the chassis.

Replacement

1. Insert capacitors into their respective receiving holes.
2. Replace hold-down screws to secure capacitors to the chassis.

3. Reconnect wires to capacitors and verify that wiring is in accordance with *Figure 2-13*.

Wires must be replaced exactly as removed. In some instances, a quick-connect wire terminal does not seat properly if it is not placed on the terminal cluster exactly as it was before removal. Sometimes the insulation on the wire terminal interferes with the insulation surrounding the terminal cluster on the capacitor.

Section 4 — Replaceable & Spare Parts

Customer Service

Customer Service: 1-800-821-5825
Telephone: (615) 261-2000
Facsimile: (615) 261-2600
Shipping Address:
Flash Technology Corporation of America
332 Nichol Mill Lane
Franklin, TN, 37067

Ordering Parts

To order spare or replacement parts, contact FTCA customer service at 1-800-821-5825.

Power Converter Parts

Table 4-1 lists the major replaceable parts for the power converter.

External Controller Parts

Table 4-2 lists the major replaceable parts for the FTC 425 External Controller.

Control Interface Parts

Table 4-3 lists the major replaceable parts for the CI 425 Control Interface.

Internal Controller Parts

Table 4-4 lists the major replaceable parts for the FTC 415 Internal Controller.

Series Controller Parts

Table 4-5 lists the major replaceable parts for the FTC 435 Series Controller.

Flashhead Parts

Table 4-6 lists the major replaceable parts for the FH 400 Flashhead and the FH 800 Flashhead.

Returning Equipment

Before returning equipment, call Customer Service at 1-800-821-5825 for a Return Material Authorization (RMA) number.

Repackaging

Return equipment in a container that provides maximum protection during shipping and handling. If the original cartons and packaging material are no longer available, package the units as follows:

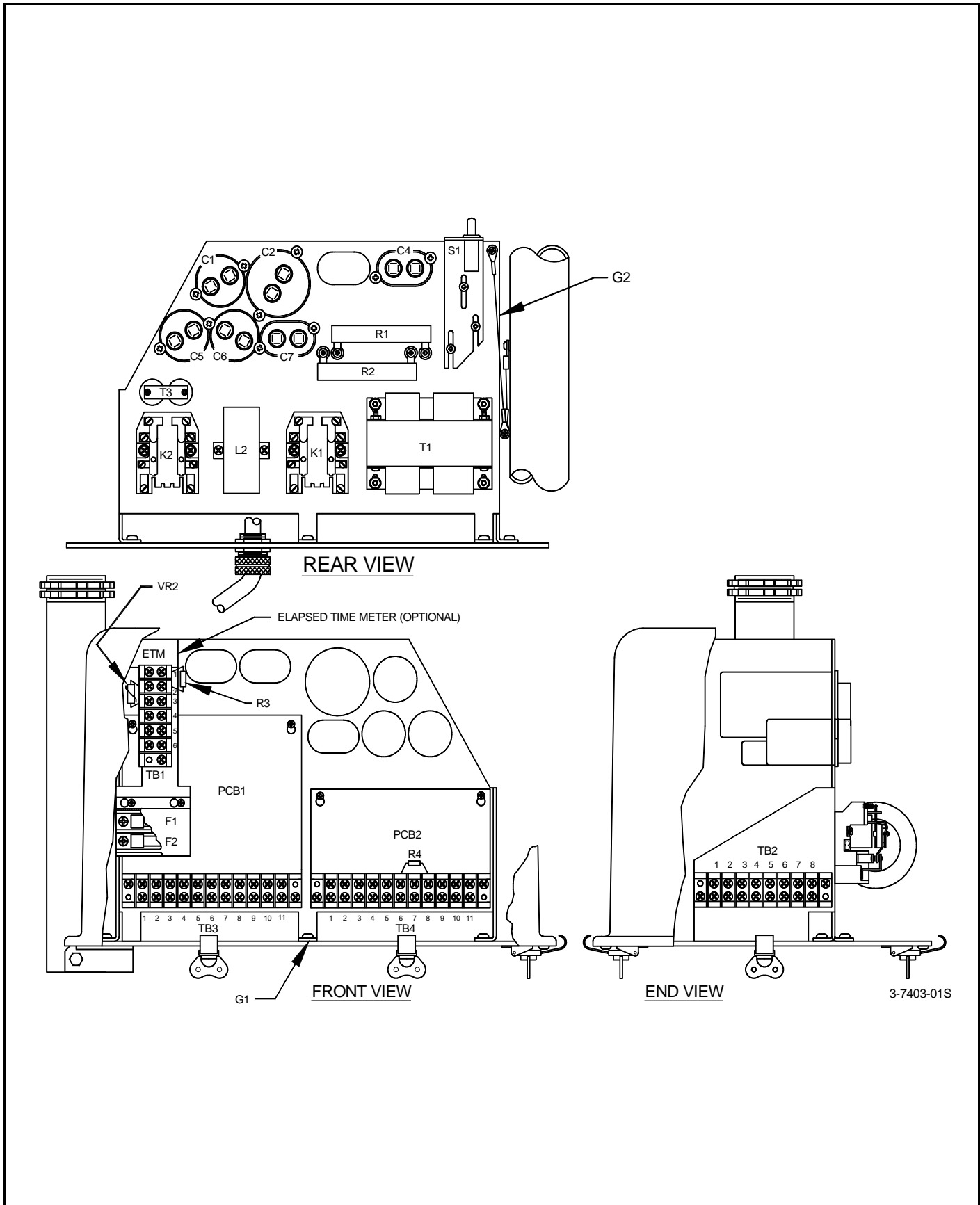
Ship and package the *power converter* in an upright position; that is, with the feet downward. Pad the unit so that the feet cannot penetrate the box during shipment. Box each unit separately using a double thickness cardboard container and adequate padding. Do not drop. Use appropriate warning labels on the outside of the container.

If you send the *flashhead* separately, package it in any reasonable, strong, corrugated cardboard box with enough firm padding surrounding the flashhead to prevent damage.

Table 4-1 Power Converter Major Replaceable Parts

Unit	Description	Part Number	Quantity
All	Enclosure	3727901	1
All	Spacer, Ceramic	5900842	2
All	R1, Resistor, 35K, Bleed	6900541	1
All	R2, Resistor, 50K, Bleed	6900542	1
All	T1, Transformer, Power: 120VAC 230/240VAC 60hz 230/240VAC 50hz	8841201 8841202 8842901	1 1 1
All	K1/K2, Relay, Mode	8900494 [†]	2
All	L2, Choke, Flash	4175200	1
All	T3, Transformer, Trigger Coupling	8336710	1
All	TB2 Terminal Strip, 8-position	8721008	1
All	PCB2, HV Rectifier Board	2458002 [†]	1
All	R4, Resistor	8435212	1
All	Terminal Strip, 11-position	8721011	2
All	PCB1, Timing and Trigger Board, unprogrammed	2652318 [†]	1
All	F1/F2, Fuse, Power	4900342	2
All	VR1, Suppressor	6901081	1
All	VR2, Suppressor	6901079	1
All	TB1, Terminal Strip, 6-position	8721006	1
All	R3, Resistor, Buffer	8435211	1
All	Interlock Switch	4901220	1
PC800	C1, 20 mfd. capacitor	6731401	1
PC800	C2, 70 mfd. capacitor	6720401	1
PC800	C4, 3 mfd. capacitor	6577903	1
PC800	C5, C 6, 15 mfd. capacitor	6731301	2
PC800	C7, 5 mfd. capacitor	6731101	1
PC400	C1, 20 mfd. capacitor	6731401	1
PC400	C2, 40 mfd. capacitor	6386503	1
PC400	C4, 3 mfd. capacitor	6577903	1
PC400	C5, C6 15 mfd. capacitor	6731301	2
PC400	C7, 8 mfd. capacitor	3731201	1
Optional	ETM Elapsed Time Meter	1749201	1
Optional	K3 Flash Monitor Module	1851001	1

[†] Recommended as a spare part. NOTE: Program the spare board (PN 8652318) by removing the diodes in the spare to match exactly those that are removed in the PCB1 board that you are replacing.



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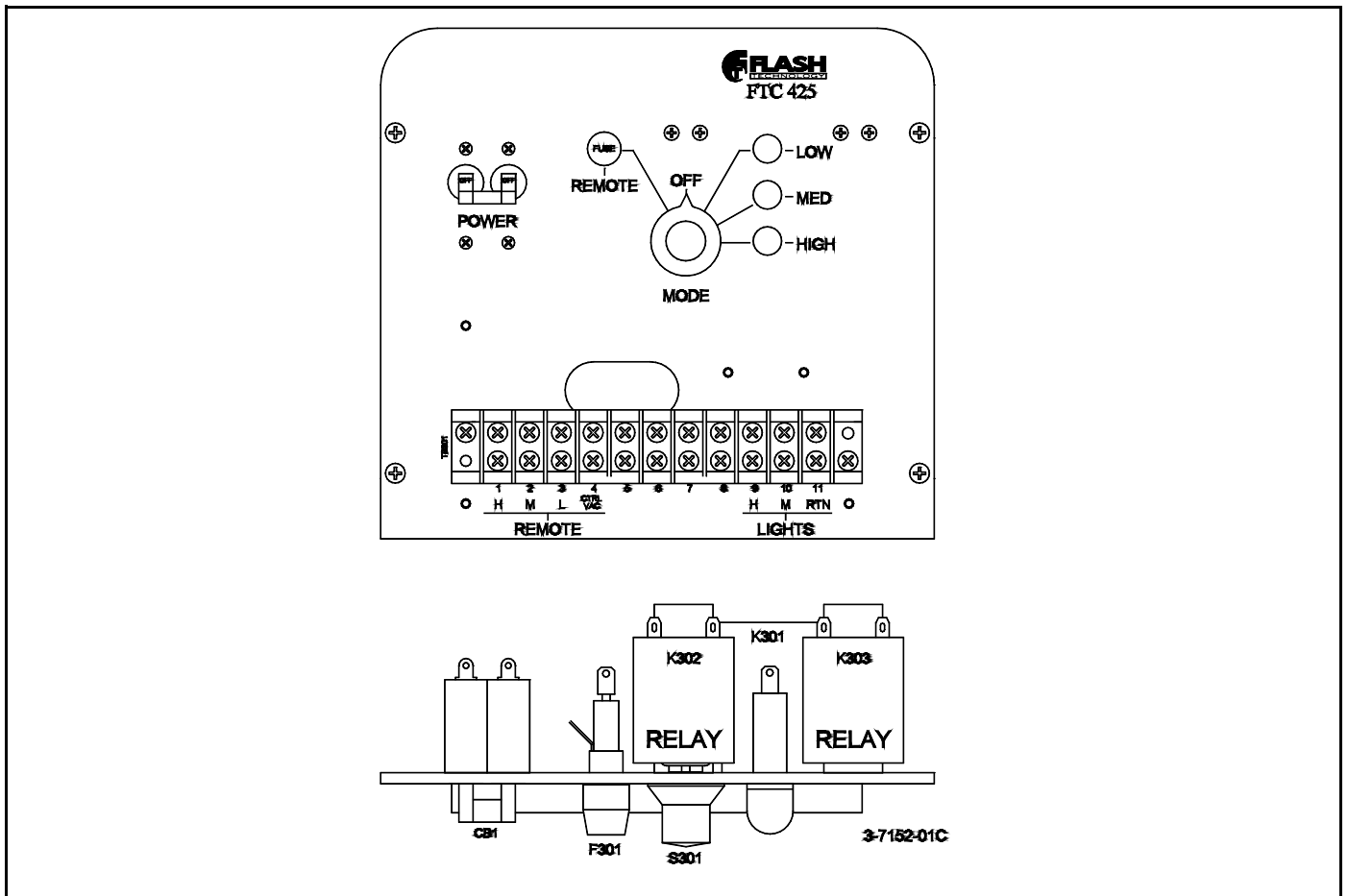
Figure 4-1 PC 400 and PC 800 Power Converter Component Locations

Table 4-2 FTC 425 Controller Parts

Description	Part Number	Quantity
Enclosure	3714800	1
Relay: Mode, K301 or K302		
120VAC	4900501	2
230/240VAC	4901762	2
Switch, Rotary	4900893	1
Terminal Strip, 11-position	8721011	1
Suppressor:		
120VAC	6901079	1
230/240VAC	6901081	1
Fuse Holder	4900377	1
Fuse: MDL2, 2 AMP, 120VAC	4900342	1
Relay: Power, K303		
120VAC	8900493	1
230/240VAC	4900495	1
CB1 Circuit Breaker	4900120	1
Low, Med, High, Lamp:	4901749	3

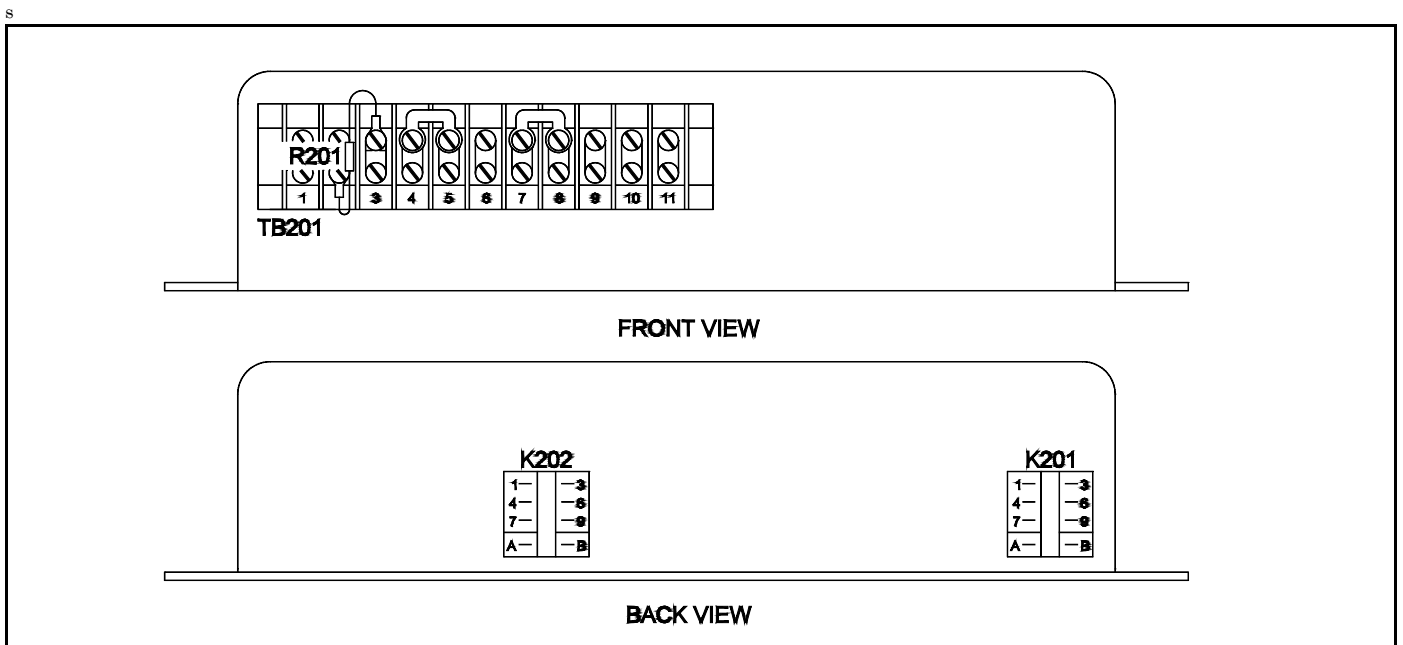
Table 4-3 CI 425 Control Interface Parts

Description	Part Number	Quantity
Relay, Mode:		
120VAC	4900501	2
230/240VAC	4901762	2
Terminal Strip, 11-position	8721011	1
Resistor	8435210	1



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Figure 4-2 FTC 425 System Controller Component Locations



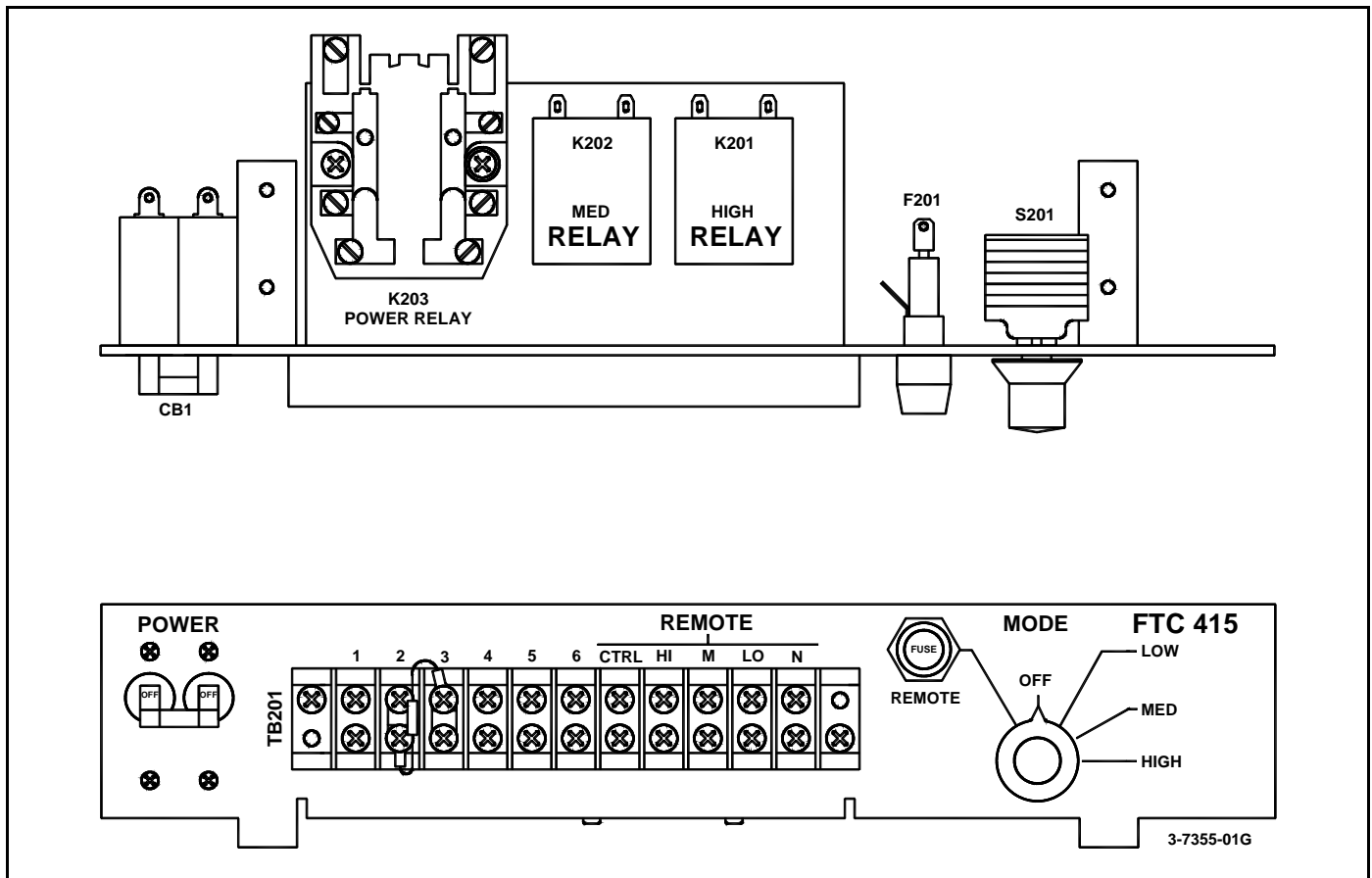
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Figure 4-3 CI 425 Control Interface Component Locations

Table 4-4 FTC 415 Controller Parts

Description	Part Number	Quantity
Relay: K203< Power 120VAC 230/240VAC	8900493†	1
	4900495†	1
Relay: K201 & K202, Mode 120VAC 230/240VAC	4900501†	2
	4901762†	2
S201 Rotary Switch	4900893	1
F201 Fuse	4900342	1
Fuse Holder	4900377	1
TB201 Terminal Strip, 11-position	8721011	1
Suppressor: 120VAC 230/240VAC	6901079	1
	6901081	1
Resistor	8435210	1
CB1 Circuit Breaker	4900120	1

† Recommended as a spare part.

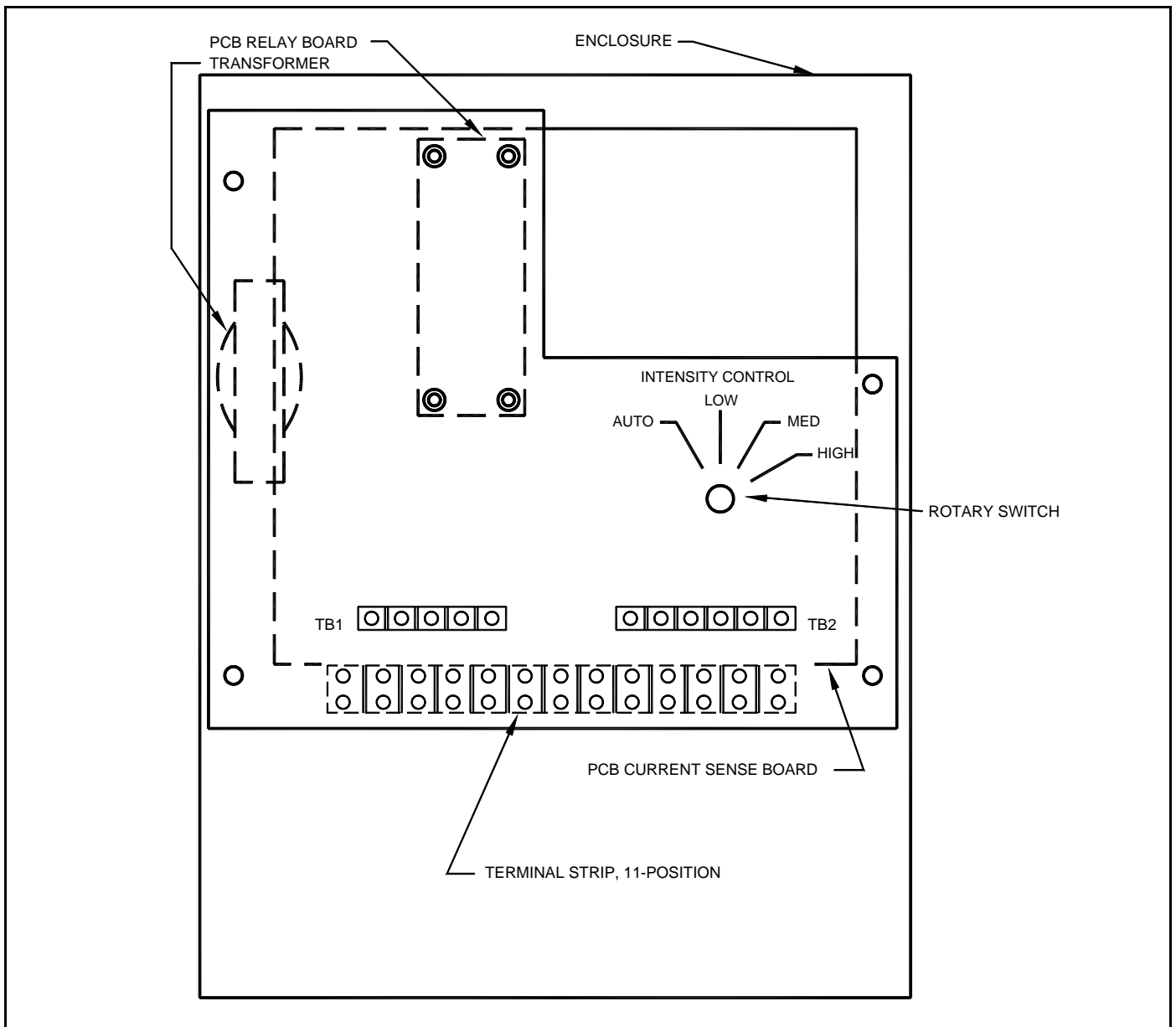


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Figure 4-4 FTC 415 Controller Component Locations

Table 4-5 FTC 435 Controller Parts

Description	Part Number	Quantity
PCB, Current Sense Board	2760702	1
PCB, Relay Board	2767902	1
Enclosure	3714800	1
Transformer	4734500	1
Switch, Rotary	4900892	1
Terminal Strip, TB1, 3-position	4902157	1
Terminal Strip, TB2, 4-position	4902073	1
Terminal Strip, 11-position	8721011	1



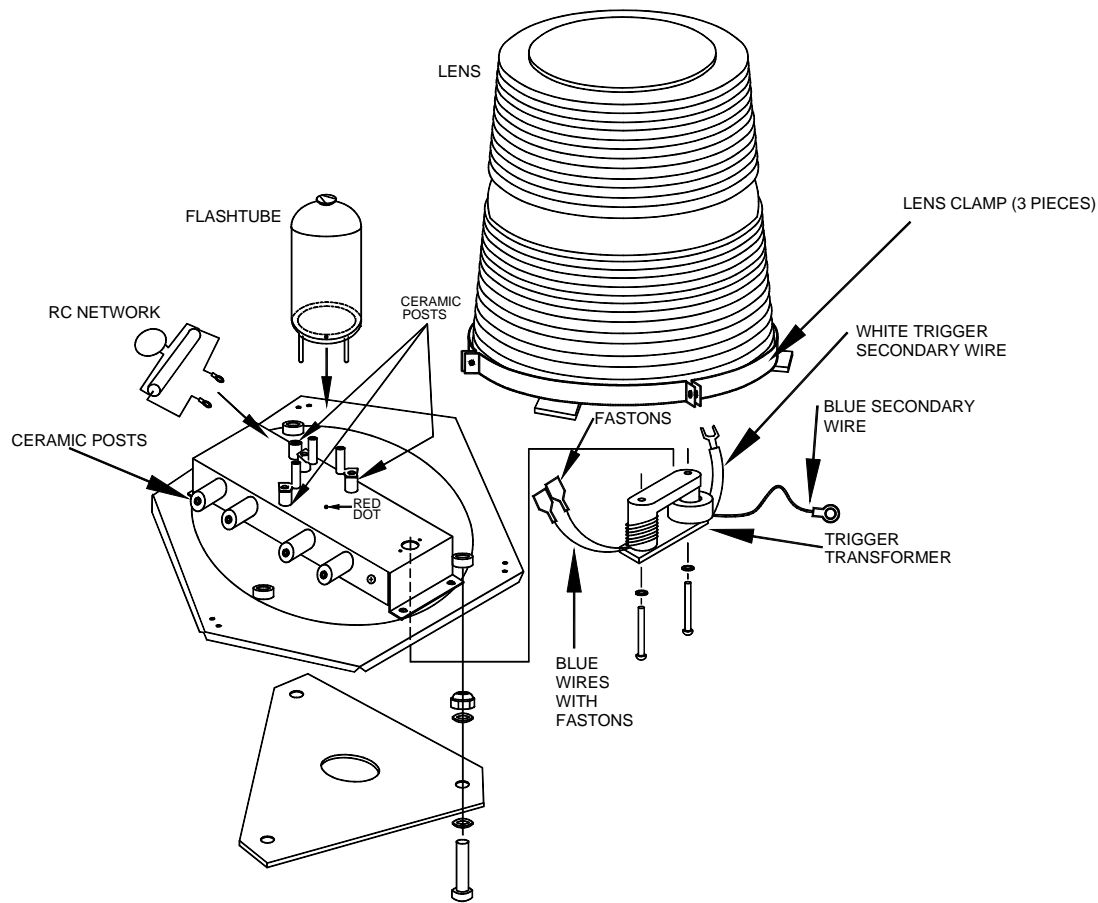
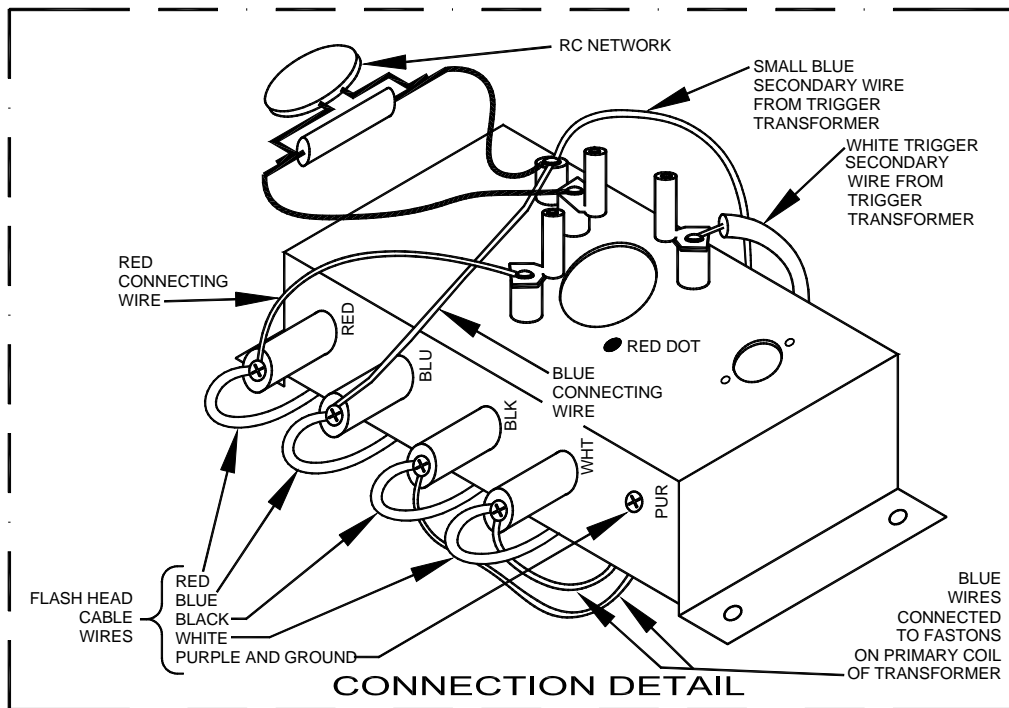
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Figure 4-5 FTC 435 Series Controller Component Locations

Table 4-6 FH 400 and FH 800 Flashhead Major Replaceable Parts

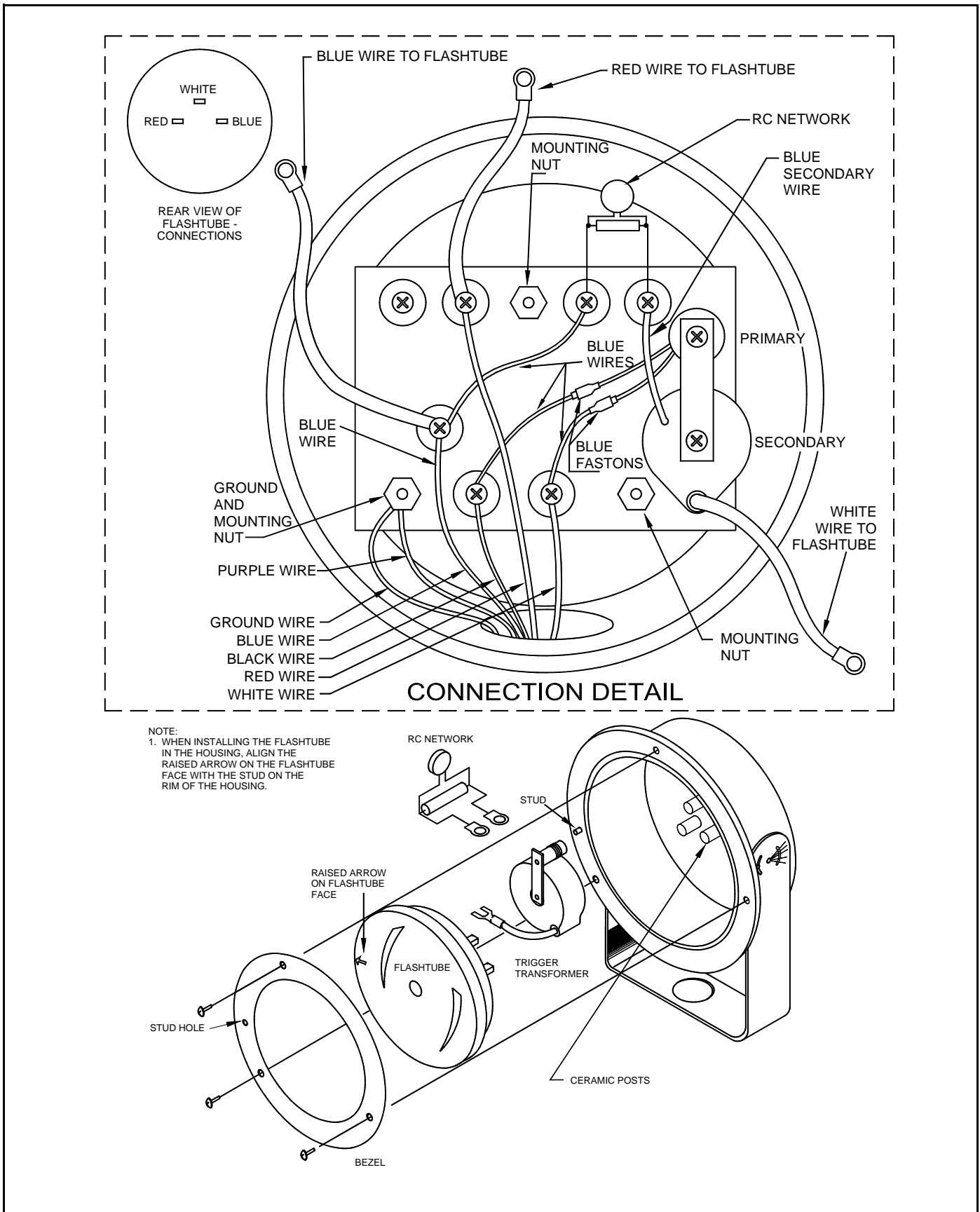
Flashhead	Description	Part No.	Quantity
FH 400	Lens	8743701	1
FH 400	Trigger Transformer	8288201	1
FH 400	Clamp, Lens	3893201	3
FH 400	Spacer, Ceramic	5900844	4
FH 400	RC Network RC101	1403411	1
FH 400	Flashtube FT 101	8384329 [†]	1
FH 400	Terminal Screw Lug	3379102	3
FH 400	Spacer, Ceramic	5900842	4
FH 800	Flashtube FT101	8901701 [†]	1
FH 800	RC Network RC101	1403411	1
FH 800	Trigger Transformer	8288201	1
FH 800	Post, Ceramic	5900842	4
FH 800	Retaining Bezel	3735202	3

† Recommended as a spare part.



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Figure 4-6 FH 400 Flashhead Component Locations



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Figure 4-7 FH 800 Flashhead Component Locations

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