The ATC Cabinet Guide

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Introduction

The ATC Cabinet (ATCC) is the latest national standard for traffic signal cabinets. It supersedes all existing cabinet standards, including NEMA TS 1, TS 2, Caltrans (33*x*), and ITS v1.

The advantages of the ATC Cabinet are embodied in five core themes:

Functional

- Control up to 32 output channels to support additional bicycle, flashing yellow arrow, and overlap signals
- Obtain data from up to 120 detectors to support high resolution data collection and other advanced detection scenarios

Efficient

- Save space with smaller, high-density components
- Use less power with lower wattage LEDs
- Decrease wiring and cabling runs
- Only purchase the assemblies and modules needed for the intersection

Safe

- Protect motorists from dark approaches
- Protect technicians from high voltage and arc flash hazards
- Protect the public from high voltage field wires

Serviceable

- Readily access the rear of assemblies with swing-down panels
- Swap out assemblies with ease with fewer connectors
- Toolless removal of cooling fans

Reliable

- Sealed flash transfer relays prevent intrusion of moisture and other contaminants
- Monitor the flasher outputs to prevent surprises during cabinet flash
- Use load current monitoring to detect partial and complete signal outages

Additional advantages are provided specifically by the Cubic ATCC, with features that differentiate it from competitive offerings. Look for the Cubic logo throughout this document to identify these features.

History

The effort to design the ATC Cabinet started when a working group comprised of consultants, agencies, and vendors was formed in 2008 to advance and modernize Version 1 of the ITS Cabinet standard, which is from 2006. The effort was driven by the following:

- The change from incandescent to LED bulbs
- Ban on mercury relays
- Regulations to eliminate shock hazards in the cabinet
- Regulations to eliminate shock hazards of field wiring
- Regulations to eliminate arc flash hazards
- Need to replace internal components while in flash
- Need to decrease power consumption to facilitate alternate power sources

After years of work, the working group approved the standard In October 2018, naming it *ATC 5301 v02.02*. (The standard is at Version 2 because it is considered an evolution of Version 1 of the ITS Cabinet standard from 2006.)

The Cubic ATCC meets or exceeds ATC 5301 v02.02.

Modular Architecture

A major design theme of the ATCC is a modular architecture. Compared to legacy cabinet architectures that use monolithic components such as back panels (NEMA) and output files (Caltrans), a modular architecture has the following advantages:

- The user only purchases the modules that they need, saving expense and space
- Modules can easily be added in the future as needs arise
- As technology advances, modules can be swapped out with modules that have new technology without affecting the other modules
- The user can choose the position and arrangement of the modules in the cabinet
- It is less expensive to replace a failed module than a larger, monolithic part
- When a module fails, it can be replaced independently without affecting the operation of other modules

The flexibility of a modular architecture is perhaps exemplified by the fact that a high voltage (120 VAC) ATCC can be changed to a low voltage (48 VDC) cabinet by simply changing a few modules.

Everything in engineering has pluses and minuses, though. The tradeoff for the increased flexibility offered by modularity is cost and additional points of failure where modules interconnect. For example, the pins and other module connectors are relatively expensive and add potential points of failure. While it would possibly be less expensive to put everything on a single board and perhaps more reliable to eliminate the connection points, it would eliminate the advantages of modularity.

Types of Modules

The major modular units of the ATCC are called *assemblies*. Assemblies contain, themselves, other smaller devices called *components*. In general, the connections between assemblies are not defined in the standard, whereas the pin connections and sizes of components are.

The physical elements of the ATCC are classified into assemblies and components, while its logical functionality is classified into six modules called subsystems:

- Controller
- Monitoring

- Input
- Output
- Power
- Communications

These subsystems are described in the following sections.

Controller Subsystem

The ultimate purpose of any traffic control cabinet is, of course, to safely connect, house, and monitor the equipment that is used to operate signals. Under normal operation, the ATCC is operated by a Controller Unit (CU), which controls signals based on inputs that it receives from detectors.

The CU has two connections with other modules:

- Serial communications buses: SB1 and SB2
- AC power

When using Cubic software, the ATCC can only be operated by Scout running on a Model 2070 or Commander.

To operate an ATCC with a Model 2070, the CU must be equipped with a 2070-2A, 2070-2E, or 2070-2B field I/O module. The 2070-2A and 2070-2E modules have C1 and C11 connectors, which are expensive. The 2070-2B forgoes these parallel I/O connectors in favor of serial communications connectors. In either case, the ATCC serial communications busses connect to C12S, which is a 25-pin "D" subminiature connector.

Figure 1: 2070 Field I/O Modules

Parallel I/O connectors – such as the 170/2070 C1 and NEMA TS 1 A/B/C connectors – are not used in the ATCC cabinet. With that said, CUs that have these connectors can still operate an ATCC cabinet; their parallel I/O connectors will simply not be used.

The CU can put the cabinet into flash if it detects a malfunction, for example, if it detects that the signal outputs do not match the outputs that it is commanding. This feature must be in the CU software.

Monitoring Subsystem

The Cabinet Monitor Unit (CMU) is the heart of the ATCC monitoring subsystem. The CMU is connected to both in-cabinet serial buses (SB1 and SB3). The CMU is designated “Model 2212” by the ATCC standard.

The width of the Model 2212 face plate was decreased as the ATCC standard developed. Therefore, early versions of the Model 2212 that were produced before the standard was approved have a wide face plate, whereas later versions have a narrow face plate. This can be a problem when a user attempts to install a pre-standard (wide) Model 2212 in an Output Assembly that conforms to the approved standard (narrow), because the pre-standard Model 2212 will not fit in the narrower opening. Fortunately, Cubic ATCC Output Assembly has a unique feature that accommodates both the existing and pre-standard Model 2212s.

Figure 2: Model 2212 CMU

The ATCC standard supports multiple CMUs, which allows one controller to operate up to four cabinets – one primary cabinet and three remote, auxiliary cabinets, each with its own CMU. This configuration could be used where I/O counts exceed the capacity of a single cabinet, or where there are signal heads that are so far from the primary cabinet (such as on the opposite side of an interchange) that a remote cabinet is needed to prevent voltage drop. The multi-CMU capability must be supported in software. There are no known deployments of this configuration.

When the cabinet is in flash, a relay interrupts 24 V DC control power to the HDSPs. This ensures that a field signal indication will not remain illuminated should an FTR or the MC fail. As a troubleshooting aid, control power can be temporarily applied to the HDSPs by pressing the 24 V BYPASS button.

The CMU can also command the HDSP outputs to OFF via a message on SB3, which it does when the cabinet is in a fault state. This adds yet another safety-related redundancy, enhancing the “fail safer” design of the ATCC.

The CMU is one of the components that is specific to the cabinet voltage: there are separate models for high voltage (120 VAC) and low voltage (48 VDC) cabinets.

Configuring the CMU

Unlike legacy monitors that relied on a physical card to program the channel compatibilities (permissives), the Model 2212 stores its programming on nonvolatile flash memory device called a Datakey.

The user defines a monitor configuration using PC software called EDI MonitorKey. When the configuration is complete, the configuration is written to the Datakey using a USB reader/writer.

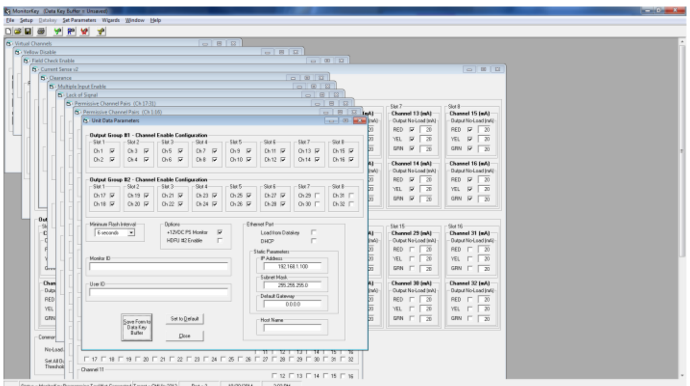

Figure 3: EDI MonitorKey software used to configure the CMU

Figure 4: Datakey USB reader/writer

By design, the Model 2212 CMU cannot write to the Datakey. You can see how the ability for the monitor to write to its own configuration would be a safety loophole!

Load Current Monitoring

Like the ITS Cabinet v1, the CMU in the ATCC can measure the load current of each output. The load current information is communicated from the Switch Pack to the monitor, which passes it to the controller.

It is important to understand how this differs from voltage-only monitoring. In legacy cabinet architectures, the monitor only measured the voltage of each output. The only information that this provides to the monitor is whether the output is ON or OFF. It provides no information about whether any signal lamps are connected to the output.

Load current monitoring measures the amount of electricity flowing through the circuit connected to the output, not just whether the output is ON or OFF. This allows a dark approach to be detected when the current falls below a very low threshold – typically 20 mA.

Existing CMU and CU software can only detect a totally dark channel (approach). This means that anything less than a dark approach does not cause Cabinet Flash. With that said, it is possible to detect a less-than-full outage on an approach – say, the loss of one head on a two-head approach or the loss of two heads on a three-head approach – but this capability has not been implemented.

Auxiliary Display Unit

Compared with legacy monitors (NEMA MMUs, 2018 CMUs, etc.), the space-saving high-density Model 2212 has less space available on its front panel for indicators and displays. To fill the need for a rich user interface, the Auxiliary Display Unit (ADU) was created to serve as a remote front panel for the Model 2212.

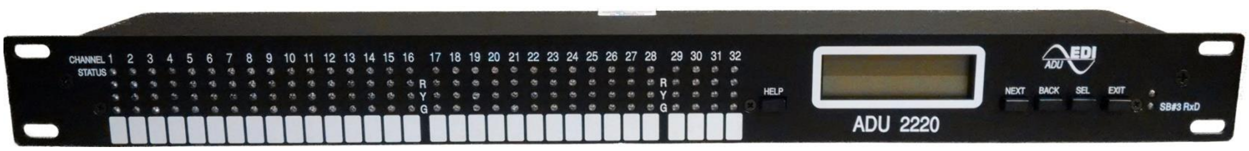

Figure 5: Auxiliary Display Unit (ADU)

The ADU is a 1U high rack mount device with a full complement of user interface controls for the CMU:

- A four-line LCD that displays channel status and other real-time operational information
- Buttons to navigate the various data displays
- LED indicators that display the input (controller/SIU command) status of all 32 channels, plus an ID indicator that identifies faulted channels
- A Diagnostic Wizard that aids in troubleshooting cabinet faults

The ADU runs on 48 V DC.

Communications Subsystem

Like ITS v1 and NEMA TS 2 cabinets, the ATCC is a serial cabinet. In serial I/O cabinets, information about inputs, outputs, and other real-time data is communicated via in-cabinet high speed communications channels. The opposite of a serial I/O architecture is parallel I/O architecture, in which cabinet assemblies are connected to the controller via large wire harnesses – such as the NEMA A/B/C/D and Caltrans C1 connectors.

While the ATCC serial communications buses are not necessarily “modules” in and of themselves – they only serve to interconnect the major assemblies – they logically comprise a major functional element of the ATCC. Understanding the role of the serial buses is vital to understanding the ATCC.

The Serial Buses

The ATCC has three serial communications channels called buses. Two of the buses – Serial Bus 1 (SB1) and Serial Bus 3 (SB3) – are required for cabinet operations. Serial Bus 2 (SB2) is optional and has not been implemented in any known deployments.

SB1 and SB3 are master/slave buses. This means that one device on the bus (the master) initiates all communications and polls the other devices (the slaves), which only communicate in response to a message from the master.

On SB1, the Controller Unit (CU) is the master, while the slaves are SIUs and the CMU. The CU tells the SIU to turn signal outputs on and off and the SIU returns information about whether detector inputs are on or off. The CU tells the CMU which outputs are on and the CMU returns various cabinet status data.

On SB3, the CMU is the master and communicates with HDSP-FUs. The CMU verifies that the outputs on the HDSP/FUs are operational and (in the case of HDSPs) checks whether their outputs correspond to the commands from the controller – a feature called Field Check. This is possible because the CMU is also on SB1 and, as we will learn later, receives the CU's output commands to the SIUs.

Serial Interface Units

SIUs are components that act as intermediaries between the CU, the signal outputs, and the detector inputs:

- When installed in Output Assemblies (output SIU), they receive commands from the CU and actuate the appropriate red, yellow, and green outputs on the HDSPs accordingly.
- When installed in Input Assemblies (input SIU), they read the status of detector inputs from isolator cards and communicate this information to the CU.

Conceptually, SIUs are like TS 2 BIUs. SIUs are designated "Model 2218" by the standard.

SIUs are installed in slots in Output Assemblies and Input Assemblies:

- The 16 channel OA needs one SIU, while the 32 channel OA needs two.
- One SIU is required for every 24 input channels, so a 24 channel IA uses one SIU while a 48 channel model uses two.

The controller communicates with SIUs via Serial Bus 1 (SB1). Each SIU slot has a unique address. The addresses are defined by the standard and are configured by jumpers on the back panel that the SIU reads at powerup. For example, the SIU in a 16 channel Output Assembly is Address 1, while the second SIU for Channel 17 through Channel 32 is Address 3. The address can be verified by pressing and holding the button on the front panel of the SIU.

It is possible to define custom I/O mappings for SIUs. For example, a small CBD cabinet with just a single SIU could control 8 output channels and 16 detectors, even though this arrangement is not defined by the standard. Of course, the CU software application must be aware of any custom SIU pin maps.

EDI is the only manufacturer of SIUs. EDI private labels SIUs for other vendors.

Differences from ITS v1 SIUs

The Model 2218 SIU for the ATCC is smaller than the Model 218 SIU for the ITS v1 Cabinet, creating space. The reduced width of the Model 2218, for example, creates space for an optically isolated input toggle switch panel on the left side of the Input Assembly. The switches can be assigned functions in the controller to activate different features of the user's choosing.

Output Subsystem

The output subsystem is responsible for switching and monitoring power to signal indications in the field.

The ATCC supports up to 32 output channels.

High Density Switch Pack/Flasher Units

The workhorses of the output subsystem are High Density Switch Pack/Flasher Units, which have six outputs that switch loads (signals) and measure voltage and current. HDSP/FUs are designated "Model 2202" by the ATCC standard.

As its name suggests, an HDSP/FU can function as either a switch pack or a flasher, depending on where it is installed:

- When installed in the Output Assembly, an HDSP/FU acts as a switch pack and controls two channels of three outputs (red, yellow, and green) each.
- When installed in the Service Assembly, an HDSP/FU acts as a flasher and controls two flashing circuits (four outputs).

Figure 6: Model 2202 High-Density Switch Pack/Flasher (high voltage model shown)

The HDSP/FU is perhaps the component of the ATCC that is the most radical departure from previous components. It is an intelligent, microprocessor-based device unlike the Model 200 load switches that have been used since the 1970s.

For example, the legacy Model 200 load switches used a component called a triac to switch the load. Triacs have 1.5–1.8 watt inefficiency, which creates heat. You may have noticed that Model 200 load switches are hot to the touch.

Instead of triacs, HDSP/FUs switch loads using a more modern component called a mosfet, which does not have the inefficiencies of triacs. As a result, HDSP/FUs do not run hot.

Also, the triac-based Model 200 load switches exhibit a phenomenon called leakage current, whereby they still pass current even when the output is OFF. This only occurs when the output is loaded with less than 7 W and is why unused outputs (pedestrian yellow, protected/permissive red, etc.) must be loaded with load resistors. Load resistors are a waste of energy, because they dissipate power as heat instead of light, which also causes the temperature in the cabinet to increase.

With HDSP/FUs, loading unused outputs with load resistors is a thing of the past, as are the inefficiencies and heat caused by load resistors. Unused outputs are simply flagged as such in the CMU configuration. Lower cabinet temperatures generally make the cabinet more reliable.

HDSP/FUs can switch loads between 5 mA and 1 A, so they are compatible with ultra low power LED signal lamps, such as those 2 W and below. However, this switching range also means that they are not intended for use with incandescent signal lamps, which could easily exceed 1 A (120 W @ 120 V) on a channel.

The HDSP/FU measures the voltage and load current of each output, which it communicates to the CMU. This is described further in the Monitoring and Communications section.

HDSP/FUs have a variety of indicators on their front panel:

- The channel LEDs indicate the status of the control inputs to the HDSP.
- The flasher LEDs indicate the status of the output voltages.
- A blue ID indicator is controlled by the CMU as a troubleshooting aid. For example, when there is a conflicting indication failure, the CMU turns the ID indicator for the conflicting channels.

Output Assembly

Every ATCC must have an Output Assembly (OA). The OA is a rack-mounted assembly that houses the Cabinet Monitor Unit (CMU), High-Density Switch Packs (HDSPs), and Serial Interface Units (SIUs). It also has circuit breakers for the outputs and switches for Stop Time and Flash.

The Main Contactor (MC) is also housed in the OA behind a panel.  In the Cubic ATCC, the Main Contactor can be optionally located on the side panel, external to the OA for better accessibility.

The OA has four connections with other assemblies:

- Communications (SB1, SB3)
- AC Power

- DC Power
- Field Output Termination Assemblies

Unlike legacy cabinets, the flasher and power sources in the ATCC are in another assembly, the Service Assembly (SA). Because of this, the OA can be replaced while the signals remain in flash. In legacy cabinets, replacing a back panel or output file resulted in a dark intersection.

While custom OA designs with different channel counts are possible, such as smaller form factors for compact CBD-size cabinets, the most common types of OAs are 16 channel and 32 channel units. (A channel consists of three outputs – red, yellow, and green). Both types of OA have one CMU, but the 32 channel OA needs two SIUs, as opposed to the single SIU in the 16-channel model.

The 16 channel OA is a 3U-high assembly that has slots for eight HDSP/FUs. The slots are numbered from left to right, Slot 1 through Slot 8. Each HDSP/FU has six outputs (two channels). Slot 1 has Channel 1 and Channel 2, Slot 2 has Channel 3 and Channel 4, and so on, through Slot 8 with Channel 15 and Channel 16.

The 32 channel OA is a 6U-high assembly that has slots for 16 HDSPs. The slots are numbered like the 16 Channel OA, with an additional row of 16 HDSPs (Channel 17 through Channel 32) and an additional SIU.

Figure 7: Output Assembly (32 channel model shown)

The OA has a back panel with connectors into which the CMU, HDSPs, and SIUs plug.

Each SIU in the OA can control up to eight HDSPs, for a total of 16 channels (48 outputs). The outputs on the HDSPs are switched via 24 VDC control lines, of which there is one for each output running between the HDSPs and the SIU.

Finally, the OA has a circuit breaker for every four channels.

Field Output Termination Assembly

Every Output Assembly must be paired with a Field Output Termination Assembly, on which signal wires are terminated. The FOTA also has the following components:

- Flash Transfer Relays (FTRs)
- Flash Program Blocks (FPBs)
- MOV-based surge suppressors (optional)

Figure 8: Field Output Termination Assembly

On the FOTA, field wires are terminated and secured on convenient, removable screw terminal blocks.

The FOTA swings down and out of the way for easy access to the rear components and PC board.

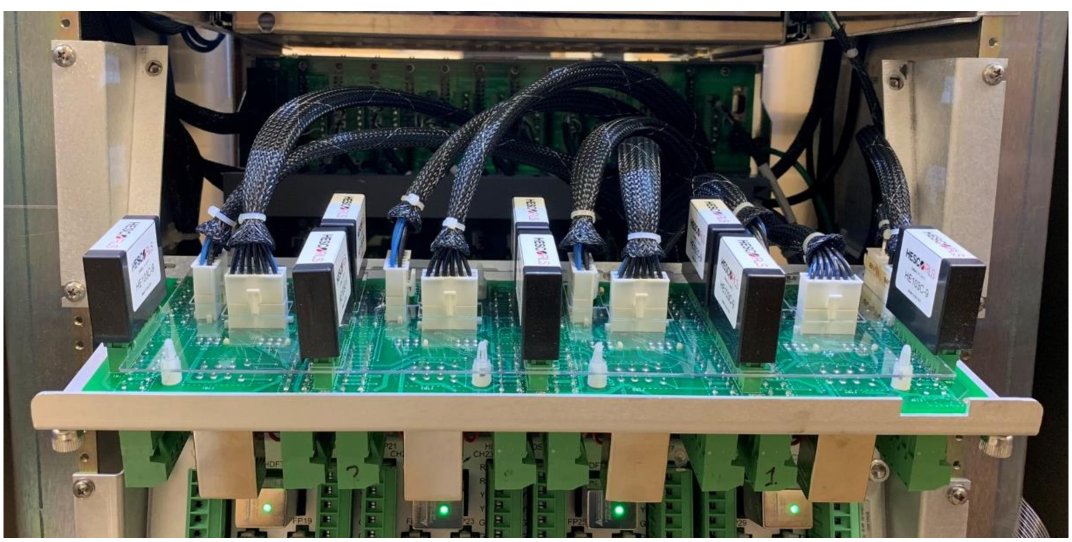

Figure 9: FOTA in down position

The FOTA accommodates pluggable MOV surge suppressors, which can be ordered with the cabinet or added later. Each MOV protects two channels.

Flash Transfer Relays

Flash Transfer Relays switch electricity between the flasher bus and the signal bus. Their size and pinout are defined in the standard.

Flash transfer relays in legacy cabinets had a 120 VAC coil and were susceptible to intrusion by contaminants, such as moisture and insects. This contamination could cause malfunctions.

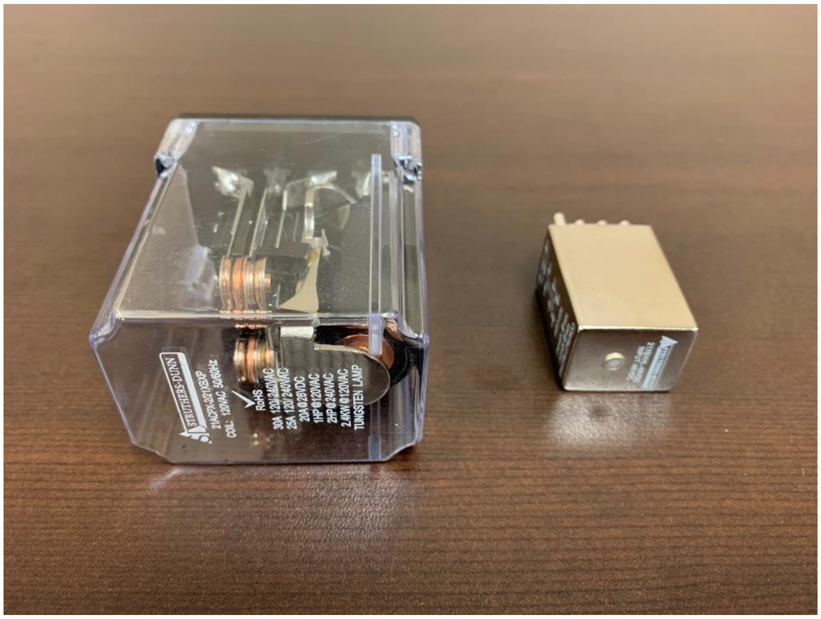

Figure 10: Flash transfer relays (legacy on left, ATCC on right)

Flash transfer relays in the ATCC are hermetically sealed (airtight), meaning that moisture, dirt, dust, insects, and other contaminants cannot enter. This makes them much more reliable.

Another improvement provided by the ATCC FTRs is the status LED. On legacy FTRs, the status indicator showed the state of the coil, which only tells the technician whether the relay is ON or OFF but does not convey anything about the flow of electricity through the relay; it was possible for the FTR coil to be energized but, at the same time, for no electricity to flow through the relay due to a malfunction of the contacts. On the other hand, the status indicator on the ATCC FTR shows the actual status of the contacts – in other words, whether the contacts have "made" the connection.

Input Subsystem

The input subsystem is responsible for isolating and sensing detector inputs from the field and relaying their state to the CU for processing.

Input Assembly

The ATCC supports up to 120 detector inputs. Typically, these inputs will be processed via isolator cards in the Input Assembly (IA). The IA also contains SIUs that convert discrete parallel I/O detector inputs to serial messages that are transmitted to the CU via SB1.

There are two typical IA configurations:

- The 24 channel IA is a 3U high assembly that has one SIU and slots for 12 isolator cards (for a total of 24 detector inputs)
- The “high density” 48 channel IA is a 3U high assembly that has two SIUs and slots (for a total of 48 detector inputs)

Figure 11: Inuput Assemblies (24 ch on top, 48 ch high density on bottom)

The IA was purposely designed to work with all existing detector and isolator cards, including Model 222 loop detectors, Model 242 DC isolators, Model 252 AC isolators, and preemption phase selectors.

The channels are numbered from the upper left of the assembly to the lower right. Each slot has two detector inputs, “A” (upper) and “B” (lower). The slots are numbered sequentially from left to right. Therefore, the first (leftmost) slot has Channel 1 and Channel 2, while the last (rightmost) slot has Channel 23 and Channel 24.

The IA has four connections:

- DC power
- AC power
- Communications (SB1)
- Field Input Termination Assembly

There are two ways to wire the pedestrian push buttons in the ATCC:

- Use the SIU’s optically isolated inputs
- Use Model 242 DC Isolator cards

The former will be more familiar to users coming from legacy NEMA cabinet architectures, while the latter will be more familiar for Caltrans/33x cabinet users.

Field Input Termination Assembly

Every Input Assembly must be paired with a Field Input Termination Assembly (FITA) on which cables from loop detectors, push buttons, and other input devices are terminated. Two styles of FITA are available:

- The horizontal FITA is a 3U high assembly that is typically mounted as the bottommost assembly on the rear of the cabinet; it swings down for easy access
- The vertical FITA is mounted to the cage at the left rear of the cabinet; it swings out for easy access

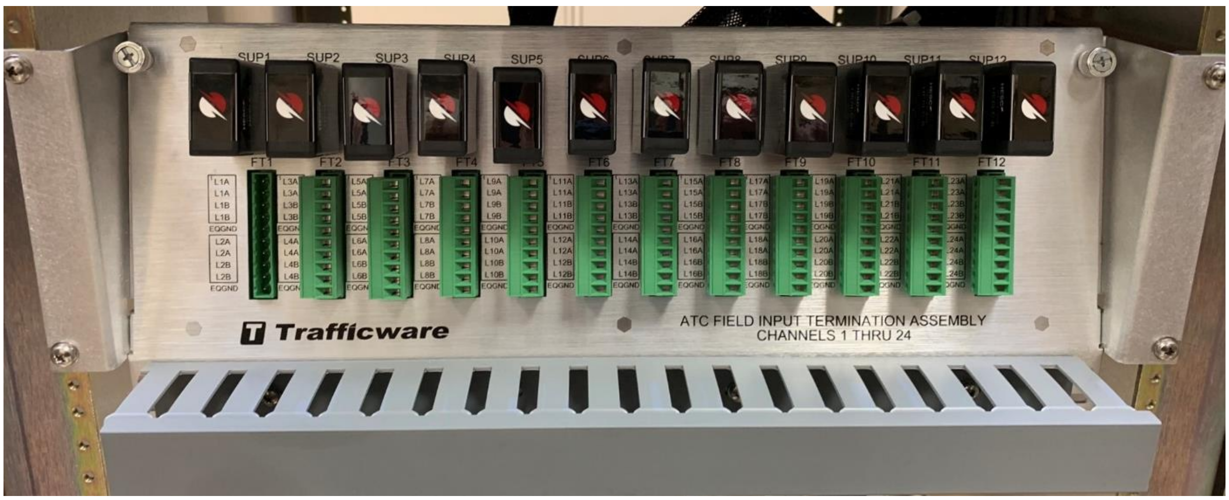

Figure 12: Field Input Termination Assembly

The FITA has convenient, removable screw terminal blocks to terminate and secure field wires. Each screw terminal block has two pairs of terminals for each detector input channel. The screw terminal blocks are clearly labeled with the number of the detector channel to which they correspond.

The FITA has sockets for MOV-based surge suppressors. Each suppressor protects two input channels. Input surge suppressors are optional; they can be ordered with the cabinet or added later.

A FITA is not always necessary. The user can optionally choose to terminate field wires directly to the IA, bypassing the FITA.

Figure 13: Detectors terminated directly to IA, bypassing FITA

Power Subsystem

The ATCC standard does not define cabinet sizes or configurations. For example, there is no definition of a "352" cabinet in the standard. Rather, the ATCC standard defines cabinet versions in the context of signal bus power:

- Low voltage: 48 V DC signal bus
- High voltage: 120 V AC signal bus

(There is, actually, a third version – Very High Voltage (240 VAC) – but it is reserved for future revisions of the standard.)

The primary difference between these versions is the voltage that is used to drive the signals. Otherwise, the voltages used to operate the assemblies and components are the same in the high voltage and low voltage ATCCs.

Clean vs. Raw Power

When it comes to AC power in the ATCC, you will see two terms used, "Clean AC" and "Raw AC". The two are on two separate AC power buses.

Raw AC power is neither surge protected nor filtered. It is only intended to power non-vital equipment used by technicians, such as computers and vacuums.

Clean AC power is surge protected and filtered. It is intended to provide AC to vital assemblies and components in the cabinet, including the Controller Unit and, in high voltage cabinets, the signals.

Surge Suppression & Noise Filtering

The ATCC standard defines a modular, pluggable surge suppressor/filter. The ASCO Model 258 (Edco SHA-1250) is one such example of this component.

Figure 14: Pluggable Surge Suppressor & Filter (shown on base)

The surge protector has two indicator LEDs. Normally, the green LED is ON and the red LED is OFF. If the red LED is ON or the green LED is OFF, the surge protector has a problem and should be replaced.

AC Power Distribution

The ATCC has a distribution bus for Clean AC power. (Remember that Clean AC is filtered and conditioned, as opposed to Raw AC, which is unfiltered and unconditioned.)

The Clean AC Bus in the Cubic ATCC has eight outlets. Typically, three of them are occupied, supplying power to the Power Supply, Controller Unit, and Output Assembly.

The remaining outlets are available to power ancillary equipment and electronics, such as detection equipment, networking and computing equipment, etc.

Power Supply

In AC cabinets, the Power Supply converts 120 VAC to the various DC voltages needed by other assemblies and components in the cabinet:

- 5 A @ 24 V DC: detector isolator (input) cards, HDSP-FUs, SIUs
- 1 @ 48 V DC: Main Contactor, Flash Transfer Relays, Auxiliary Display Unit
- 5 A @ 12 V DC (optional): detector isolator (input) cards

As shown above, the Power Supply can be purchased with just 24 and 48 VDC, or with 12, 24, and 48 VDC. Running detector cards on 12 VDC can save about $1/year versus running them on 24 VDC.

There are two styles of power supplies:

- A 1U high rack-mounted assembly, designated Model 2216 by the standard, is the most common style.
- A pluggable card format, designated Model 2217 by the standard, is intended for compact cabinet designs where space is a concern.

Figure 15: Model 2216 Rack-Mount Power Supply (shown with optional 12 VDC)

Figure 16: Model 2217 Pluggable Card Power Supply

The Power Supply is highly efficient (86%), which is more efficient than legacy power supplies. It therefore runs cooler, which helps prolong the life of its electronics as well as the life of other electronics in the cabinet.

Each of the DC voltages is fused. LEDs next to each fuse serve to quickly convey the integrity of the fuse, aiding in troubleshooting.

The Low Voltage ATCC

We have mentioned that one of the two types of cabinets defined by the standard is a low voltage, DC cabinet. Again, the difference between the AC and DC cabinets is the signal voltage: 120 VAC in the high voltage cabinet, 48 VDC in the low voltage cabinet.

To be clear, there is DC in both the high voltage and the low voltage cabinet, but it is only used as a control voltage for internal subsystems in the high voltage cabinet and is not sent to the signals.

Of course, it follows that different signal lamps that run on 48 VDC need to be used in low voltage cabinets. At least one signal lamp manufacturer is producing 48 VDC lamps of all types (ped, arrow, ball, etc.).

When discussing low voltage 48 V DC cabinets, it is important to keep in mind that low voltage does not necessarily mean low power. Ohms law tells us that, for a given load, current is inversely proportional to voltage. Therefore, current must increase to compensate for lower voltage. In other words, a 10 W LED signal will use 10 W, whether it is a high voltage (120 VAC) lamp or a low voltage (48 VDC) lamp.

With that said, DC heads will be inherently more efficient, because they do not suffer from AC-to-DC conversion losses. Future DC signal heads may use 4 W or less.

A low voltage DC cabinet would normally be ordered from the factory. However, it is possible to convert a high voltage AC cabinet to a low voltage DC cabinet by replacing the following high voltage (HV) components with their equivalent low voltage (LV) components:

- HDSP/FUs
- Power Supply
- CMU
- Signal lamps

Advantages of DC Operation

Low voltage, DC operation is such a radical departure from AC cabinets. Rightfully, agencies may wonder why they would need a DC cabinet. Why should they care? Is saving a couple of watts here and there worth the investment? “That's the way the world is heading” may not be enough of an inducement for such a disruptive change.

One main advantage of DC is safety for field personnel working in the cabinet, due to the minimal exposure or even absence of exposure to high voltage. This can also reduce licensing requirements for technicians.

The other huge advantage of DC is that the public is safer if a pole is knocked down and wires exposed.

Other advantages include more efficient and cost-effective circuits, both in the cabinet and the signal heads. Existing signal wiring is 12 AWG and 14 AWG, but in the future it may be possible to switch to 16 AWG or even 18 AWG.

At the end of the day, though, we give our customers an option by offering both AC and DC versions. Only they can determine which solution will suit them better.

Concerns about DC Operation

Some customers may be concerned about corrosion in cables that carry DC voltages. It is important to reassure them that a negative 48 volts should not produce corrosion. The power supplies in the low voltage cabinet are isolated such that they could be operated as -48 V DC with respect to Earth if desired.

Furthermore, the “corrosion” (ion migration) caused by a positive conductor with respect to Earth Ground is not an issue with the larger conductors that are used in the ATCC. In the telecom world, the wires were much smaller, making them susceptible to the detrimental effect of ion migration. Ion migration also requires a great deal of moisture to produce a measurable result. These conditions do not exist in the traffic control environment.

There is also some concern about voltage drop with DC.

Most of the drop is due to heating. There is no additional heating of the field wires to speak of. While reducing voltage from 120 VAC to 48 VDC does increase the load current by a factor of 2.5, the I*2R losses of 14 AWG or 16 AWG wire are not significant. In practice, the wattage of the signal heads will be at least a factor of two less than existing 110 VAC technology. The first 48 VDC signal heads tested from one manufacturer were 4.5 watts compared to a typical 12 watt AC signal.

Sizes

The ATCC standard permits great flexibility in cabinet sizes and arrangements, while the modularity of the ATCC allows customization to fit users' needs. For example, assemblies can be rack or shelf mounted.

Some ATCC sizes are new, while others are equivalent to legacy cabinets. Low-level details such as sizes and assembly placement are not defined by the standard; rather, they are specified by vendors and agencies.

Customization

Like all other cabinets, there are endless ways to customize the ATCC; Cubic currently offers 15 different top-level ATCC configurations.

While reading this guide, keep in mind that descriptions of cabinets and assemblies provided herein represent default "starting points" that are not set in stone and can be customized to suit the user's needs.

Sizes Offered by Cubic

Cubic offers three sizes of cabinets that are more or less a standard in the industry:

- A size that is equivalent to the Model 332 (Caltrans) cabinet. It has been named "352" by vendors and agencies; this name is not a standard.
- A size that is equivalent to a Model 336 (Caltrans) cabinet. It has been named "356" by vendors and agencies; this name is not a standard.
- A size that is equivalent to a Model 340 (ITS v1) cabinet. Its footprint (bolt pattern) also matches NEMA P and NEMA R cabinet foundations. It has been named "350" by vendors and agencies; this name is not in the standard.

Competitive Sizes

Other vendors have ATC Cabinet sizes that are equivalent to other Caltrans cabinets (such as the Model 337), equivalent to other types of NEMA cabinets, and unique compact sizes for central business district (CBD) or beacon (HAWK) applications. Some of the latter type use a 14-inch rack.

Sales Strategies

Keep the five themes of the ATCC in mind – functional, safe, efficient, reliable, and serviceable – during presentations and continually relate details back to one or more of these themes. For example, the

ATCC switch packs generate less heat. Heat is the enemy of electronics. Less heat means longer lifespan. Longer lifespan means less money spent (efficient), fewer failed parts (safe, efficient), fewer trouble calls (user friendly).

Do not focus on technical minutiae and rattle off facts; traffic engineers and technicians probably don't care. For example, while it is true that ATC Cabinet SDLC bus operates at a higher speed than NEMA TS 2 SDLC, this is a low-level detail that nobody needs to know about, because it does not relate to one of the hallmarks. With that said, make sure that you know this information to be able to answer the question if it arises.

Determine how familiar the audience is with ATCC technology. If they have not experienced it before, focus more on a training and education mentality. If they have seen other vendor's ATCCs, there may still be an opportunity for training to show our understanding of the product, but more of the focus should be on the differences and unique aspects of the Cubic ATCC.

FAQ

What makes the Cubic ATCC unique?

- Choice of black (high contrast) or natural (anodized) finish on assembly sheet metal
- Field upgradable Output Assembly from 16 to 32 channels
- Option of mounting Main Contactor on side instead of inside Output Assembly
- Choice of full-width (horizontal orientation) or vertical orientation Service Assembly
- Ability to omit Field Input Termination Assembly (FITA) and terminate detectors directly on Input Assembly

Are NEMA BIUs compatible with the ATC Cabinet?

No. While the electrical characteristics of the ATCC and NEMA variants of SDLC are similar (they both use four pairs of cables and use the same voltages), they use different messages and speeds. Also, SIUs and BIUs are different sizes and have different edge connectors (pinouts).

Are ITS v1 Cabinet SIUs and AMUs compatible with the ATC Cabinet?

No. The form factor and pinout of the ATCC SIU (Model 2218) is different from the ITS v1 SIU (Model 218). Also, the ITS v1 AMU is not used in the ATCC; its functions are performed by the HDSP/FU in the ATCC.

Are Caltrans and NEMA input cards (detector, isolator, etc.) compatible with the ATC Cabinet?

Yes. The ATCC standard intentionally defined the same input card form factor in the Input Assembly.

Can Model 170 controllers operate an ATC Cabinet?

No. Inputs and outputs in the ATCC are controlled via serial messages and SIUs, rather than via a C1 connector. The Model 170 does not have the proper serial ports (its serial ports are asynchronous, not synchronous) and does not have enough processing power (the ATCC serial bus operates at 614,400 bits per second).

Can Model 2070 controllers operate an ATC Cabinet?

All Model 2070 controllers – both the pre-ATC models (2070L & 2070E running OS-9) and the ATC models (2070LX running Linux) – have the synchronous serial ports and processing power to operate the ATCC.

However, not all Model 2070 software applications can operate the ATCC – even those that supported the ITS Cabinet v1 (2006). Therefore, it depends on the software.

Can existing NEMA controllers operate an ATC Cabinet?

Maybe. The NEMA controller must have a synchronous serial (SDLC) port that supports the ATCC pinout and speed, and the software application must support the ATCC protocol. In addition, provisions must be made in the cabinet to support the shelf-mount controller in the rack.

Are assemblies from different manufacturers interchangeable?

The connections between major cabinet assemblies are not standardized, so mixing and matching assemblies from different vendors is only possible if the vendors use the same connectors. For example, the connectors between the Input Assembly and the Field Input Termination Assembly are not defined by the standard, so there is no guarantee that one manufacturer's IA can connect with another manufacturer's FITA.

How many inputs and outputs do SIUs support?

SIUs have 54 configurable input/output pins and four optically isolated inputs. The position of the SIU in the cabinet determines the functions of the pins. When running as an input SIU, its pins are configured as 24 inputs and 24 outputs. When running as an output SIU, its pins are configured as 48 outputs (16 channels of three outputs each).

What enclosures and sizes are available?

The ATCC uses the same housing as the "standard" Caltrans and ITS cabinets. For example, the 352 enclosure is identical to the 332 housing, and the 350 housing is identical to the 340 enclosure. See the "Sizes" section elsewhere in this guide.

Is LED dimming possible with the ATC Cabinet?

There is no provision in the ATCC standard for dimming. A dimming strategy would have to be defined by the standards development committee.

Also, at this time, LED power supplies cannot be dimmed, because they are designed to maintain the output intensity of the signal over a wide voltage range.

Finally, dimming may not be recommended by LED signal head vendors.

Is the current monitoring feature of the switch packs sensitive enough to pick up on failures of individual diodes or "strings" of multiple diodes?

The load current system monitors with an accuracy of a few milliamps. The challenge of missing strings or signal heads is that there is no standard the defines the load current profile of LED signals over time, temperature, voltage, ambient light, etc. This will likely come in the future. For now, though, the load current monitoring system is used to detect the no-load condition (safety) immediately when it occurs.

How much does a high-density switch pack cost?

Short answer: $150 – 200

Long answer:

- The cost of the AMUs and associated other hardware that was eliminated from the ITS Cabinet v1 must also be considered as part of the value equation.
- Prices will continue to drop as the ATCC continues to be adopted and the volume of sales increases.
- The HDSP/FU is more expensive, because it is an intelligent device with reporting and current monitoring capability. These features increase reliability and reduce liability.

What are some of the advancements in safety of the ATCC?

There are many safety advancements that are described in detail elsewhere in this document. To summarize, though:

- Detect a dark approach via load current monitoring
- Replace the Output Assembly while keeping the signals in flash
- User not exposed to high voltage
- User not exposed to arc flash hazard

How can I sell the ATC Cabinet to a user who does not want to switch to it? In other words, answer the question: why do I want (or need) the ATC Cabinet?

Cite examples that relate back to the five themes – functional, safe, efficient, reliable, and serviceable – including:

- Reduced liability for the agency
- Reduced power consumption
- Safer (reference previous question)
- Differences from existing cabinets
    - More modular
    - More reliable
    - Fewer cables, less wiring, and other points of failure