HVAC

– Heating, Ventilation, and Air Conditioning

The OEM and Installers Guide to Low Voltage Electrical Control Components for HVAC Systems

c3controls.com

c3controls®
Everything under control.

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About c3controls

Since 1976 c3controls (c3controls.com) has provided OEMs and electrical equipment builders a comprehensive portfolio of industrial control products that meet the most demanding applications. By maintaining strict control over the development and manufacturing of all products, c3 can provide customers extraordinary value through unmatched quality, competitive pricing, same-day shipping and a 36-month product warranty. This vertically integrated approach coupled with a direct sales model brings c3 closer to the end-user, fostering a degree of innovation that leads the industry.

Glossary of HVAC Terms

Air Handling Unit (AHU):
A central unit that conditions the outside air by cleaning, heating or cooling, and then distributing the air within a building.

Branch Circuit Protection:
The primary method of circuit protection in a control panel provided by UL 489 miniature circuit breakers. UL 489 MCBs protect downstream systems in feeder, branch and control circuits and can be used in both UL 489 and UL 1077 applications.

Chiller:
A machine that removes heat from a liquid coolant via vapor-compression or absorption refrigeration.

Combination Motor Starter:
An electrical device that integrates the protective functions into a single unit to provide reliable motor control, motor overload protection, motor disconnecting means, motor branch circuit, short circuit, and ground fault protection.

Disconnect Switch:
A switch used to ensure that an electrical circuit is completely de-energized for service or maintenance.

Full Load Amperes (FLA):
Represents the amount of current a motor is designed to draw from the electrical system at the rated horsepower. This can be found on the motor nameplate as Amps or FLA.

Heat Pump:
A machine that pumps heat both outside and inside providing a combined heating and cooling system within a building.

Horsepower (HP):
A unit of measurement of power, or the rate at which work is done, usually in reference to the output of engines or motors.

Manual Motor Starter:
An electrical device that is non-automatic to control the electrical power for starting, stopping, reversing and/or protecting a motor.

National Electric Code (NEC):
The National Electrical Code, or National Fire Protection Association (NFPA 70), is the adoptable standard in the United States for safe electrical design, installation, and inspection of electrical wiring and equipment to protect people and property from electrical hazards.

NEMA Type 1:
Enclosures intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment. Often located where unusual service conditions do not exist.

NEMA Type 3R:
Enclosures intended for outdoor use primarily to provide a degree of protection against rain, sleet and ice. Note: NFPA 70 (National Electric Code) defines new Type 3RX as providing the same degree of protection as Type 3R, with the addition of protection against corrosive agents.

NEMA Type 4:
Enclosures intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose directed water, undamaged by the formation of ice on the enclosure.

Non-Combination Motor Starter:
An electrical device that integrates the circuit breaker and overload relay functions to provide reliable motor controller, motor overload protection, and motor disconnecting means.

Single-Phase System:
A single-phase electric power is the distribution of alternating current electric power using a system in which all the voltages of the supply vary in unison. Single-phase distribution is used when loads are mostly lighting and heating, with few large electric motors.

Supplementary Circuit Protection:
A form of circuit protection used when branch circuit protection is already provided or not required. UL 1077 supplementary protectors support individual devices and can only be used in UL 1077 applications.

Three-Phase System:
Three-phase electric power is a common type of alternating current used in electricity generation, transmission, and distribution. It is a type of polyphase system employing three wires and is the most common method used by electrical grids worldwide to transfer power.

UL508 / UL508A:
UL508 is the standard for industrial control equipment. UL508A is the standard for industrial control panels.

Ventilation System:
Ventilation is the process of exchanging or replacing air in any space to provide high indoor air quality.

Overcoming HVAC Challenges

For more than 50 years, c3controls has been a leading manufacturer of quality electrical controls for HVAC applications. We maintain strict control over our manufacturing processes to deliver reliable, high-quality controls built for demanding applications. Our experience serving the HVAC industry has given us a deep understanding of its challenges and the solutions needed to address them. The HVAC industry continues to face a variety of hurdles, including:

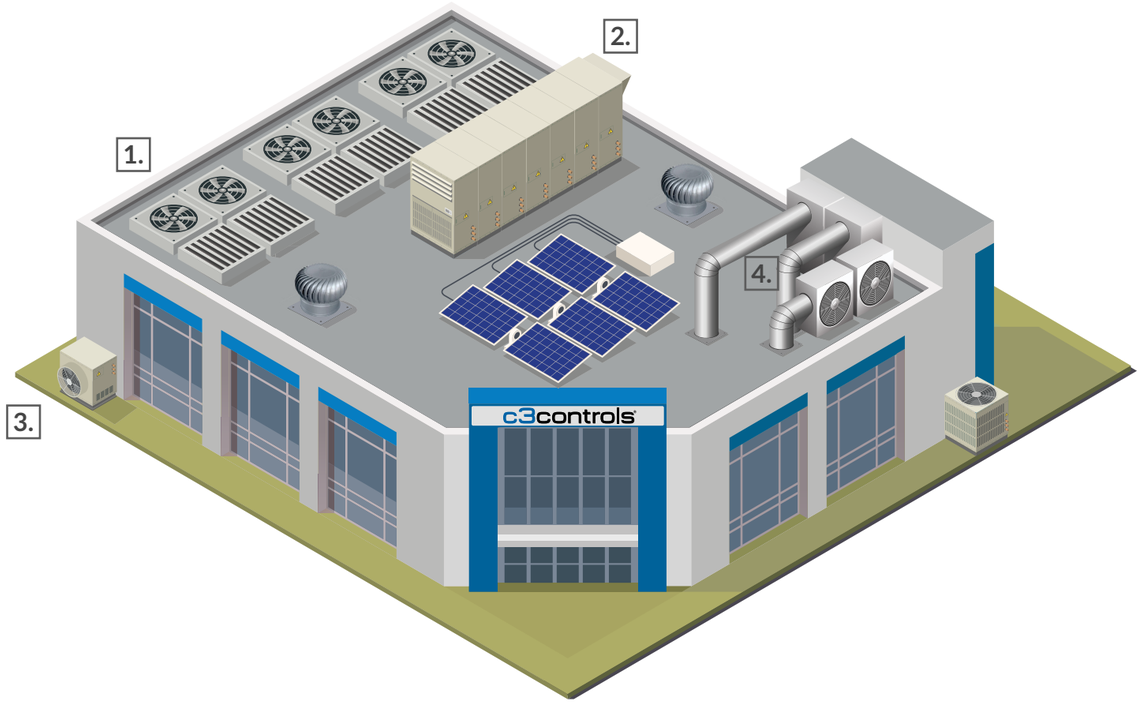
- **Supply chain issues** that bring long lead times for critical system components.
- **Workforce shortages** that limit the availability of qualified workers needed for installation.
- **New standards for indoor air quality** (from the US EPA Clean Air Challenge) that require upgrades to air handling systems.
- **Compliance with laws and regulations** (OSHA, EPA, federal, state and local agencies) that add complexity to HVAC applications.
- **Requirements for funding programs** (through the American Rescue Plan and Bipartisan Infrastructure Law) that dictate ability to make repairs and upgrades.

With these challenges come opportunities for HVAC manufacturers, contractors, and building operators to improve efficiency, reliability, and performance. With the right products, people, and processes, your HVAC application can be better equipped to meet changing demands.

c3controls can help you succeed. Our vertically integrated approach allows us to operate efficiently, respond quickly to changing market conditions, and provide reliable electrical control products with fast delivery. We maintain strict control over our manufacturing processes to deliver consistent quality and performance for demanding applications.

If you are having difficulty finding qualified electricians and engineers or need additional panel-building capacity, Covenant Panelworks (CPW) can help. As a UL 508A-certified panel shop and c3controls affiliated company, CPW provides custom and specialty control panels using quality components, including c3controls products.

With over seventeen million product configurations from c3controls and custom UL 508A-certified panel solutions from Covenant Panelworks (CPW), you have a trusted source for complete electrical control solutions. Contact us today and discover how our combined expertise can help you meet changing HVAC requirements while improving reliability, efficiency, and performance.



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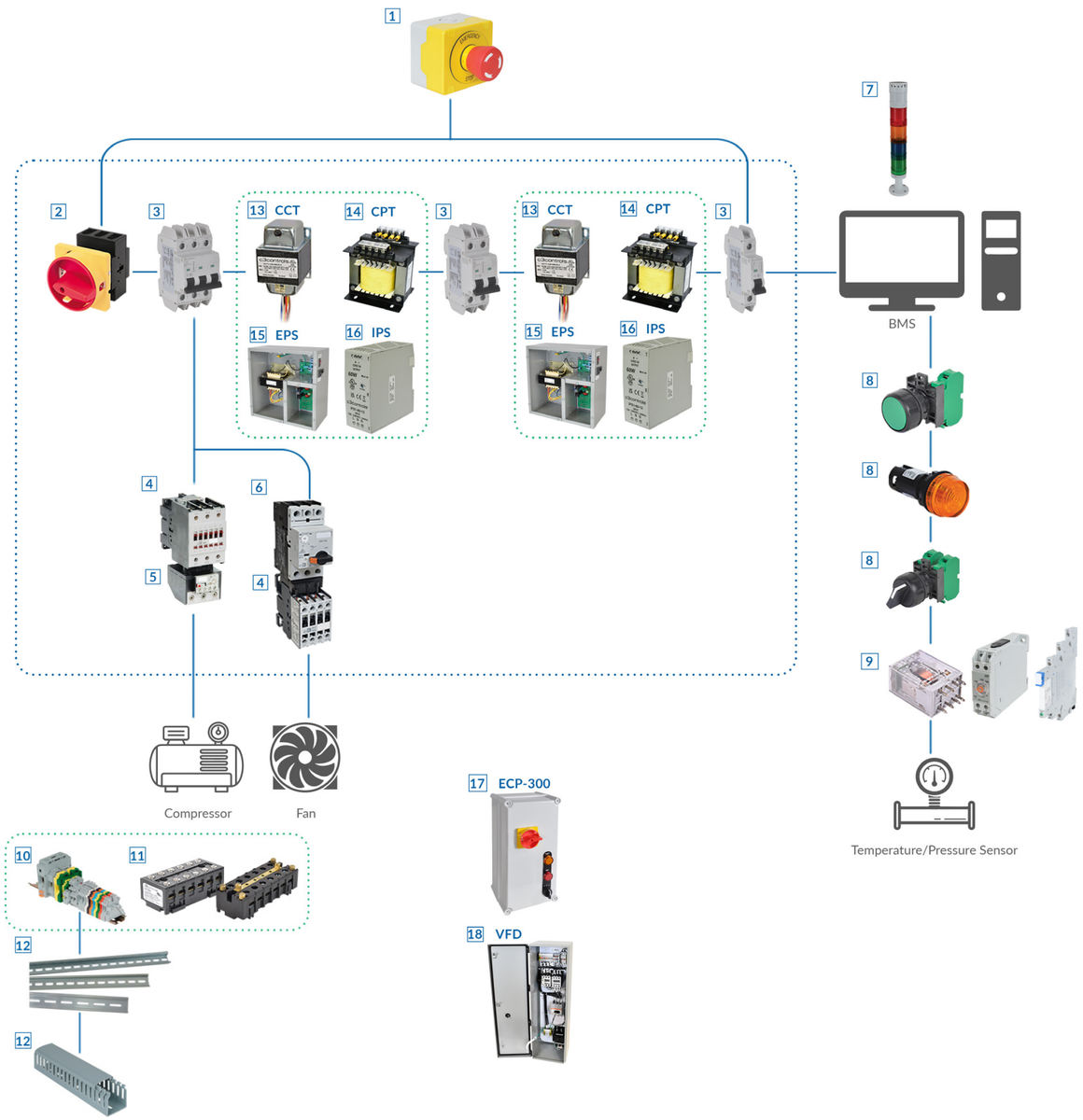
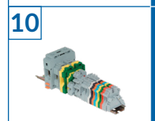
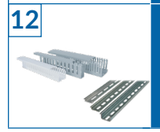
HVAC Application Example and Control Components

c3controls has component and finished solutions for all your air handling, chiller, heat pump, and ventilation systems.



For illustration purposes only. Other c3controls solutions may be applicable depending on your application design requirements.

1	**22mm IEC E-Stops**	Non-Illuminated and Illuminated versions	UL Listed Polycarbonate enclosure rated for Type 1, 2, 3, 3R, 4/4X, 12, 13, and IP66	Meets EN418 Safety of Machinery global compliance standards	Operating temperatures from -40 to +55° C (-40 to +131° F)	UV and corrosion resistant
2	**UL 508 Disconnect Switches**	Door mount, panel-base mount, and panel mount with integral operator	Certified for use in Manual Motor Controller applications suitable as Motor Disconnects	16 to 125 Amps in 3, 4 and 5 pole configurations	Motor loads up to 40HP @ 480V (55kW @ 400V)	Operating handles rated for Type 1, 2, 3, 3R, 4/4X, 12, 13, IP55, and IP65
3	**Miniature Circuit Breakers**	UL 489 & UL 1077	1, 2 and 3 Pole combinations	10kA SCCR @ 480Y/277VAC	Current ratings up to 63 Amps	B, C and D curve ratings
4	**Contactors & Control Relays**	Contactors: 9 to 105 Amps	Contactors: 100kA SCCR @ 480V and 600V with Class J fuses	Contactors: AC and DC - electronic coil control on DC devices	Control Relays: Bifurcated contacts	Control Relays: Rated 16A AC-1, A600, and Q600 for applications up to 600V
5	**Overload Relays**	Current Adjustment Range of 0.28 to 112 Amps	FLC ratio of 1:1.5	100kA SCCR @ 480V and 600V with Class J fuses	Trip Class 10	Single phase sensitivity
6	**Motor Protection Circuit Breakers**	Multi-Function: Manual Motor Controller, Motor Disconnect, Group Motor Installations	50kA SCCR @ 480V	Self-protected Type E up to 50kA @ 460V	FLC up to 32 Amps	Trip Class 10 Thermal and Magnetic Elements
7	**Tower Lights**	Stackable design for up to 5 modules in a single assembly	Mounting options in three styles: 50mm direct mount, 50mm panel-mount short base, and 50mm panel-mount tall base	Voltage options available in 24V AC/DC, 120V AC, and 240V AC	Three styles of illumination: continuous, flashing and rotary	Continuous or intermittent sound modules with 80dB or 100dB sound output
8	**Pilot Devices**	Modular range of 30mm, 22mm, 16mm, and 13mm	Type 1, 2, 3, 3R, 4/4X, 12, and 13	Non-Illuminated, Illuminated & Keyed Operators in both maintained & momentary operations	Color-coded snap-on contact blocks with angled captive screws and pressure plates	Full voltage, multi-voltage, resistor, & dual input light units in a wide range of voltages up to 600VAC/VDC
9	**Relays**	General Purpose Relays: Octal base w/pin terminals and square base w/blade-style terminals	General Purpose Relays: Color-coded push buttons for distinguishing AC and DC	Electronic Timing Relays: Sizes in 17.5mm, 22.5mm, and 45mm widths	Electronic Timing Relays: Single, dual and multi-functions with timing ranges from 0.01 seconds to 9,999 hours	Terminal Block Relays: 6A, 250VAC/30VDC rated load
10 	**IEC Terminal Blocks**	Screw Clamp, Spring Clamp, and Miniature	5mm to 25mm widths	25 to 230 Amps	Feed Through, Ground, Multi-Conductor, Double & Triple Level, Fuse Holder, Power Distribution, and more	DIN Rail mounting; snap-on, snap-off assembly
11	**High Density & CT Shorting Terminal Blocks**	2, 4, 6, and 12-point in a single molded housing	Rated for 600V, 30A continuous service	Replacement for GE CR151 and EB27B06S terminal blocks	Integrated 35mm DIN rail snap and panel mounting construction	Captive screws with spring-return open terminals
12 	**Wire Duct & DIN Rail**	Wire Duct: 13 dimensions from 25mm wide up to 80mm, and up to 2m in length	Wire Duct: Narrow and Wide Slot	DIN Rail: 35mm rails in steel and aluminum	DIN Rail: 1m (3.28ft) or 2m (6.56ft) lengths	DIN Rail: Standard package quantities or pallet options available

Power Supply Solutions

13 Control Circuit Transformers

- Ratings from 20 to 300VA
- Operating voltages from 120V to 480V on primary side, and 24V on secondary side
- Over-current protection options; inherent or non-inherent, or manual resettable circuit breaker
- Integrated grounding system and space-saving footprint
- Versatile for Class 2, Class 3, and general purpose applications

14 Control Power Transformers

- Open-type control transformers ranging from 50 to 5000VA
- Integrated terminal blocks and a finger-safe terminal guard, with IP20 protection on primary and secondary sides
- Each transformer variant features a Class H insulation system
- Capable of handling dynamic loads effectively, suitable for applications with fluctuating power demands
- Ability to provide multiple voltage outputs from a single unit

15 Enclosed Power Supplies

- 24VAC power with on/off control, power indication and equipment overcurrent protection
- Transformer steps down the input voltage to 24VAC at the output
- 100VA Ungrounded Class 2 rating per output circuit
- Optional voltage separation compartments and convenient receptacle outlets
- Durable, Type 1 metallic enclosure

16 Industrial Power Supplies

- Designed to deliver the power with up to 93% efficiency
- Adjustable voltage options in 12, 24, and 48V
- Output power range from 60W to 480W
- DC OK relay contacts are standard on 240W and 480W
- Compact design - 43mm wide, up to 60mm

Motor Starter Solutions

17 Combination Motor Starters

- Enclosure constructions in Polycarbonate or Carbon Steel
- Pre-wired assemblies include: MPCB, contactor, UL489 circuit breaker, a variety of 22mm IEC pilot devices, and external operating handle
- 50kA SCCR @ 480V in high fault applications
- Overload relay can be set to the exact FLA of the motor

18 VFD Bypass Panels

- Can be installed as either a temporary replacement to a VFD or as a system backup
- Each assembly includes: fused disconnect switch, contactors, control transformer, a variety of 22mm IEC pilot devices, and power and control terminal blocks
- Optimized width to save wall space

Industry White Papers

Product professionals AND subject experts!
Check out c3controls' extensive library of white papers:

New Trends in HVAC Industry You Need To Know

HVAC has evolved and grown over the past 120 years and there are numerous facets of developing technology still emerging. In this paper, we touch on how Smart Systems, Smart Sensors, and Internet of Things (IoT) are changing many aspects of how the industry will conduct business today. Click to learn about some of these advancements.

READ WHITEPAPER

Preparing For A2L Refrigerants

Prepare for the future of refrigeration with our comprehensive guide to A2L refrigerants. Learn about their eco-friendly composition and safe applications in HVAC-R. Read to learn more!

READ WHITEPAPER

What is Systems Integration? Exploring New Trends in Industry

Explore the cutting-edge trends shaping the systems integration industry. Discover new technologies enhancing efficiency and performance.

READ WHITEPAPER

Optimizing Control System Reliability With Redundant Power Supplies

Learn how redundant power supplies can prevent disruptions and ensure smooth operations in industrial automation. c3controls shares some practical tips to enhance system reliability and minimize downtime.

READ WHITEPAPER

Industrial Motor Control Starters & Magnetic Motor Starter

Explore the fundamentals of industrial control with c3controls. Learn about the basics of motor starters, including their function, types, and applications.

READ WHITEPAPER

Panel Essentials Series 3: UL508A Control Panel Design Considerations

Learn about the UL 508A standard for control panel design, including its requirements and recommendations.

READ WHITEPAPER

Product Portfolio

Our 17 million+ product configurations deliver durability and reliability—even in the most punishing environments—meeting and exceeding global standards for quality and safety.

series DS — DISCONNECT SWITCHES
NON-FUSED & ENCLOSED

series 1100 / series 1110 — MINIATURE CIRCUIT BREAKERS

series 300 (non-reversing) / series 310 (reversing) — CONTACTORS & CONTROL RELAYS

series 320 — OVERLOAD RELAYS

series 620 — DIRECT-ON-LINE STARTERS
CONTACTOR + OVERLOAD RELAY

series E620 — ENCLOSED DIRECT-ON-LINE STARTERS
CONTACTOR + OVERLOAD RELAY

series 330 / series E330 — MOTOR PROTECTION CIRCUIT BREAKERS
OPEN & ENCLOSED

series 630 — DIRECT-ON-LINE STARTERS
MOTOR PROTECTION CIRCUIT BREAKER + CONTACTOR

series E630 — ENCLOSED DIRECT-ON-LINE STARTERS
MOTOR PROTECTION CIRCUIT BREAKER + CONTACTOR

series 30 (industrial) / series 30 (hazardous) — 30MM PILOT DEVICES
FOR INDUSTRIAL & HAZARDOUS LOCATION

series 22 (iec) / series 22 (nema) — 22MM PILOT DEVICES
IEC & NEMA

series WTL — WORLD TOWER LIGHTS

series CS — CAM SWITCHES

series 16 — 16MM PILOT LIGHTS

series 13 — 13MM PILOT LIGHTS

series EC — CONTROL STATION ENCLOSURES

series ECP 300 — ENCLOSED UL508A COMBINATION MOTOR STARTERS

series EPS — ENCLOSED POWER SUPPLIES

series ECP BP — VFD BYPASS PANELS

series IPS — INDUSTRIAL POWER SUPPLIES

series CCT — CONTROL CIRCUIT TRANSFORMERS

series CPT — CONTROL POWER TRANSFORMERS

series TB — TERMINAL BLOCKS

series TBR — TERMINAL BLOCK RELAYS

series ETR — ELECTRONIC TIMING RELAYS

series 200 / series 210 — GENERAL PURPOSE RELAYS

series WD — WIRING DUCT

series DIN — DIN RAIL

Why choose c3controls

Integrated Manufacturing

Vertical integration is the cornerstone of c3controls as it places innovation, development, design, manufacturing, testing, and shipping all within our control. With Everything Under Control, we can ensure the highest quality and customer satisfaction.

Innovation

Product innovation is in our DNA. We approach our products as solutions. Unlike our competition, our business model allows us to provide customers with premium controls without the premium price.

Same-Day Shipping

Reduce inventory. Improve cash-flow. Save money. Our customers enjoy peace of mind knowing they'll get what they need, when they need it. Our promise, guaranteed!

36-Month Warranty

With total control over engineering and manufacturing, we are able to guarantee the highest quality products on the market—products free of defects in material, workmanship, and design.

Advantage Pricing

Total control means lower overhead and direct sales. For our customers, this translates to savings of up to 40+% on c3controls premium products.

Customer First

Commitment to the success of our customers is a core value and the driving force behind all we do. We promise concierge style service that makes doing business easy, personalized, and responsive.

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c3controls®
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