White Paper

Understanding Normal Power Sense Circuits for Emergency Lighting Control in ETC Systems

(or, Everything You Ever Wanted to Know About Sense Circuits but Were Afraid To Ask)

Defining Sense Circuits

A sense circuit is a connection to a device used for detecting the presence or loss of a power source. A sense circuit does not have a significant load connected (often 1mA or less), it is just used to detect the presence or absence of voltage.

In order to fully understand the application of sense circuit, we need to know some definitions from Article 100 of the National Electrical Code (NEC2017):

> ***Branch Circuit.*** *The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).*
>
> **Example:** The wiring between a circuit breaker and an outlet in your house.
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> ***Branch Circuit, Multiwire.*** *A branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.*
>
> **Example:** A 208V circuit that feeds a moving light, which has two hot conductors.
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> ***Control Circuit.*** *The circuit of a control apparatus or system that carries the electric signals directing the performance of the controller but does not carry the main power current.*
>
> **Example:** The DMX wiring to a Source4 LED luminaire.
>
> ***Outlet.*** *A point on the wiring system at which current is taken to supply utilization equipment.*
>
> **Example:** A normal wall outlet or ceiling mounted light fixture.

A sense circuit fits well in to the definition of a **control circuit** because it directs the performance of the controller – namely whether the system is in an emergency state or not. This means that the sense circuit cannot be used to power any **outlet;** but is used instead as a control input. The NEC describes control circuits in article 725; because the voltage of these circuits does not exceed 600V, the sense circuit should be treated as a Class 1 Remote Control and Signalling Circuit as defined by NEC 725.41(B).

Determining Normal Supplies for Sense Circuits

Now that we have determined to approach a sense circuit as a control circuit, the next question to answer is "what does the NEC requires us to sense?" Since

emergency lighting is supplied by branch circuits, NEC 700.17, ***Branch Circuits for Emergency Lighting,*** seems a logical place to start (emphasis ours):

> *Branch circuits that supply emergency lighting shall be installed to provide service from a source complying with 700.12 when the normal supply for lighting is interrupted. Such installations shall provide either of the following:*
>
> *(1) An emergency lighting supply, independent of the normal lighting supply, with provisions for automatically transferring the emergency lights upon the event of failure of the normal lighting branch circuit…*

The referenced NEC 700.12 describes general requirements of emergency systems. Of particular interest to this discussion is the opening sentence (emphasis ours):

> *Current supply shall be such that, in the event of failure of the normal supply to, or within, the building or group of buildings concerned, emergency lighting, emergency power, or both shall be available within the time required for the application but not to exceed 10 seconds.*

These sections do not differentiate between a failure caused by loss of utility power or the opening of a circuit breaker. If emergency lighting is provided by unit equipment (aka "bug eyes"), meeting these requirements is straightforward. If the normal circuit sensed by the unit equipment fails due to a power loss or a tripped breaker then the emergency battery source engages and turns on emergency lighting. However, this becomes more complicated when emergency lighting is provided by an ETC, or other, emergency lighting control system.

When emergency lighting is provided by luminaires that also act as controlled normal luminaires when normal power is present, such as auditorium house lights, meeting the above 700.17 requirements would require that the connection point of the normal sense circuit must be upstream of the control device and *downstream* of the branch circuit breaker. If power were to be sensed downstream of the dimmer or relay (the control device), the system would engage emergency lighting every time the control device was turned off. This is problematic for systems that utilize dimmer modules or circuit breakers with integrated relay functionality because, practically speaking, there is no way to sense the output of the overcurrent protective device. This requires that the sense control circuit be connected to a ***different*** source of normal-only power.

Determining which different source is appropriate for sense circuits depends on whether the panel is fed with normal-only power or normal/emergency power via an upstream transfer switch.

If a panel is fed by normal/emergency power via an upstream transfer switch, the sense circuit must be connected to a normal-only circuit in a completely different panel upstream of that transfer switch. Wording expected to be adopted in NEC 2020, updating section 700.23, specifically permits this approach to sensing normal power (proposed text additions for 2020 is in boldface below):

> ***700.23 Dimmer and Relay Systems.*** A dimmer or relay system containing more than one dimmer or relay and listed for use in emergency systems shall be permitted to be used as a control device for energizing emergency lighting circuits. Upon failure of normal power, the dimmer or relay system shall be permitted to selectively energize only those branch circuits required to provide minimum emergency illumination using a control bypass function. ***[Where the dimmer or relay system is fed by a normal/emergency source from an upstream transfer switch, normal power sensing for this function shall be permitted to be from a normal-only power source upstream of the transfer switch.]*** All branch circuits supplied by the dimmer or relay system cabinet shall comply with the wiring methods of Article 700.

If a panel is fed by normal-only power, an emergency lighting transfer switch will be required to transfer the emergency load from the normal-only panel to an emergency panel. In this case, the sense circuit may be connected to one of two normal-only sources: (a) a constant circuit breaker in the same panel and on the same phase as the branch circuit being transferred, or to (b) a tap kit installed in the same panel. Remember, the choice of these two points is dictated by the fact that in some dimming and relay equipment the output of the normal-only branch circuit breaker is not available as a sense connection.

It is our position that since section 700.23 already allows for normal-only power sensing at a point other than the output of the branch breaker supplying an emergency load, the two connection points listed above are also permissible. Further, it is our position that sense circuits should be connected to a point ***as close to the normal branch circuit as possible*** in order to provide a safe and practical emergency lighting control system.

Sense Circuits for ETC Systems Applications

Based on the fact that sense circuits are Class 1 Remote Control and Signalling Circuits, and the rationale described above, here are our recommended practices for normal sense circuits:

	Emergency Energization Method		
Normal Location of Emergency Branch Circuit	Transfer Circuit Using UL 1008 Branch Circuit Transfer (SC1008)	Transfer Multiple Circuits Using UL 1008 Transfer (ELTS2)	UL 924 Control Bypass with Upstream Transfer Switch
ERP	Tap between branch circuit breaker and control card	Use the phase loss sense terminals in the ELTS2 to sense the normal main feed to the ERP	Use an EBDK to sense the normal feed upstream of the transfer switch supplying the ERP
ERP-FT	Tap from the normal branch circuit being transferred, upstream of the ERP-FT relay	Use the phase loss sense terminals in the ELTS2 to sense the normal feed to the panel supplying the ERP-FT branch circuits	Use an EBDK to sense the normal feed to the transfer switch upstream of the breaker panel supplying the ERP-FT branch circuits
Sensor IQ	a) Tap from a non-controlled IQ breaker on the same phase as the emergency load b) Use a Sensor IQ tap kit to provide normal sense of the same phase as the transferred branch circuit	Use the phase loss sense terminals in the ELTS2 to sense the normal main feed to the Sensor IQ	Use an EBDK to sense the normal feed upstream of the transfer switch supplying the IQ panel
Sensor, DRd	a) Use a Sensor or DRd tap kit to provide normal sense of the same phase as the transferred branch circuit b) If using D20FB modules, use the hot output from the module for normal sense	Use the phase loss sense terminals in the ELTS2 to sense the normal feed to the dimmer rack	Use EBDK to sense normal power from: a) a tap kit from a nearby Sensor or DRd rack fed with normal power b) the normal feed upstream of the transfer switch supplying the rack
ALCR	n/a	n/a	a) When used to mirror control of normal fixtures in the same space, tap from the normal circuit providing control sense upstream of its control mechanism b) When used as a shunt relay, tap from the normal branch circuit being bypassed upstream of the dimmer or other control device
Foundry Mini Panels, Echo Room Controller	Tap from normal branch circuit being transferred upstream of Foundry/ Echo power input terminal	Use phase loss sense terminals in the ELTS2 to sense the normal feed to the breaker panel supplying the Mini Panel or the Room Controller branch circuits	a) Tap the same phase as the branch circuit off of the normal feed upstream of the transfer switch feeding the breaker panel feeding the ETC controller b) If multiple branch circuits are normal/emergency, an EBDK can be used to sense multiple phases; disable the sense feed in the ETC controller in these cases
Breaker Panel (by others)	Use included jumper to connect normal input and normal sense terminals	Use the phase loss sense terminals in the ELTS2 to sense the normal feed to the breaker panel	n/a