

# AUTOMATIC CHANGEOVER UNIT (ACU)



\* product may be subject to change, please check with Elsafe.

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# Why is an ACU needed?

The power supplies of all electrically-operated railway signalling systems are prone to disruption, whether by lightning strike, electrical system failure or supply disruption. Uninterruptible Power Supplies (UPS) don't provide cost-effective protection given that the loading of a signalling system will typically exceed 40kVA, and outages may last days. Many railway authorities opt for supplying their signalling systems primarily from nearby street Mains services, while backing-up using a Standby supply, often derived from their own traction supply system.

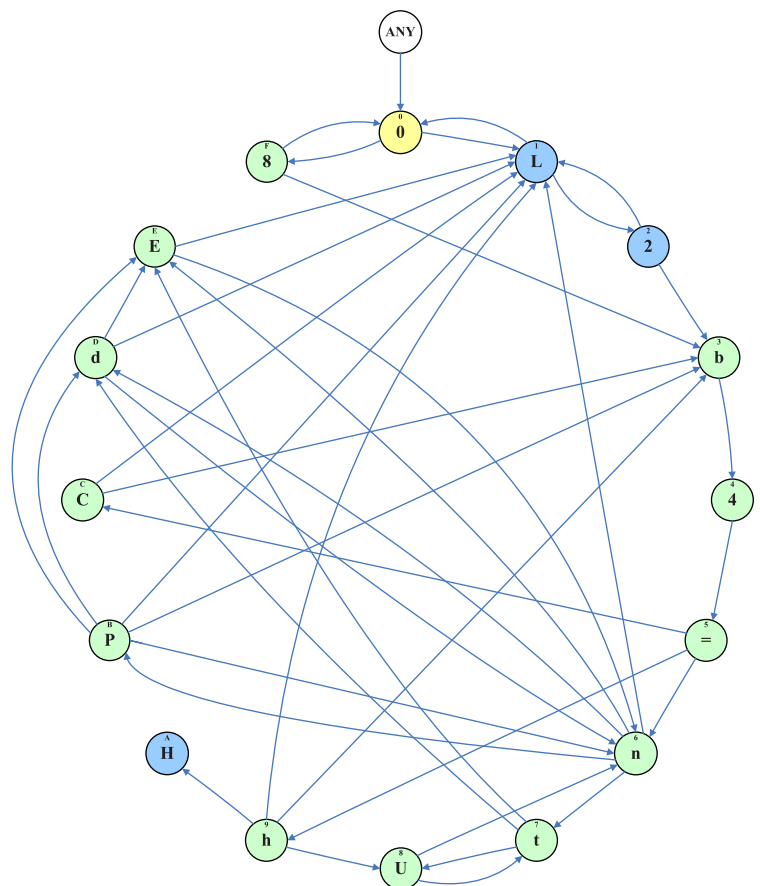
In the past, Mains and Standby sources would have been monitored by an electro-mechanical changeover system (also known as an ECO panel) which switched the Standby supply into service after the street Mains supply had gone down. Presently-deployed electro-mechanical changeover schemes typically aren't quick enough to prevent connected systems from responding to a break in supply that would result from such a changeover. Typical connected signalling equipment and relays require a break of no more than 70ms in order to maintain function. ECO switching time will vary depending on the nature of the power failure and can't guarantee the 70ms minimum holdover time that typical connected relays or other signalling equipment can sustain. In a suburban commuter network for instance, the resulting dropping-out of such relays would restore cleared signals back to red which would in turn cause approach-locking requirements to impose delays before the affected route could be re-cleared.

## ACU Features

The ACU measures the Mains **input amplitude**, **frequency**, **phase** and **current drawn** as well as measuring the Standby supplies amplitude. If the Mains supply is disrupted, or its quality becomes unacceptable (outside of settable limits) then the ACU changes over and will switch Standby through to the load. The switch over is controlled by the ACU's **SmartELogic**. This internal logic has been specifically designed in conjunction with the railway industry and is highly customisable to individual requirements. The switching voltages, and the timing of these changes to Standby supply and back, are also highly configurable.

This complex logic has allowed the inclusion of features such as **Hotspot detection**. This system detects if there is a high resistance path on the Mains supply that makes it appear that the supply is in regulation however whenever any current is drawn the supply voltage drops. After testing for this situation four times the ACU permanently switches to Standby until it is reset by an operator.

At a glance it is also easy to check on the state of the ACU and associated supply inputs, as the **front panel LED's** indicate the condition of all ACU inputs and outputs, as well as a 7-segment State Indicator that displays the SmartELogic state.



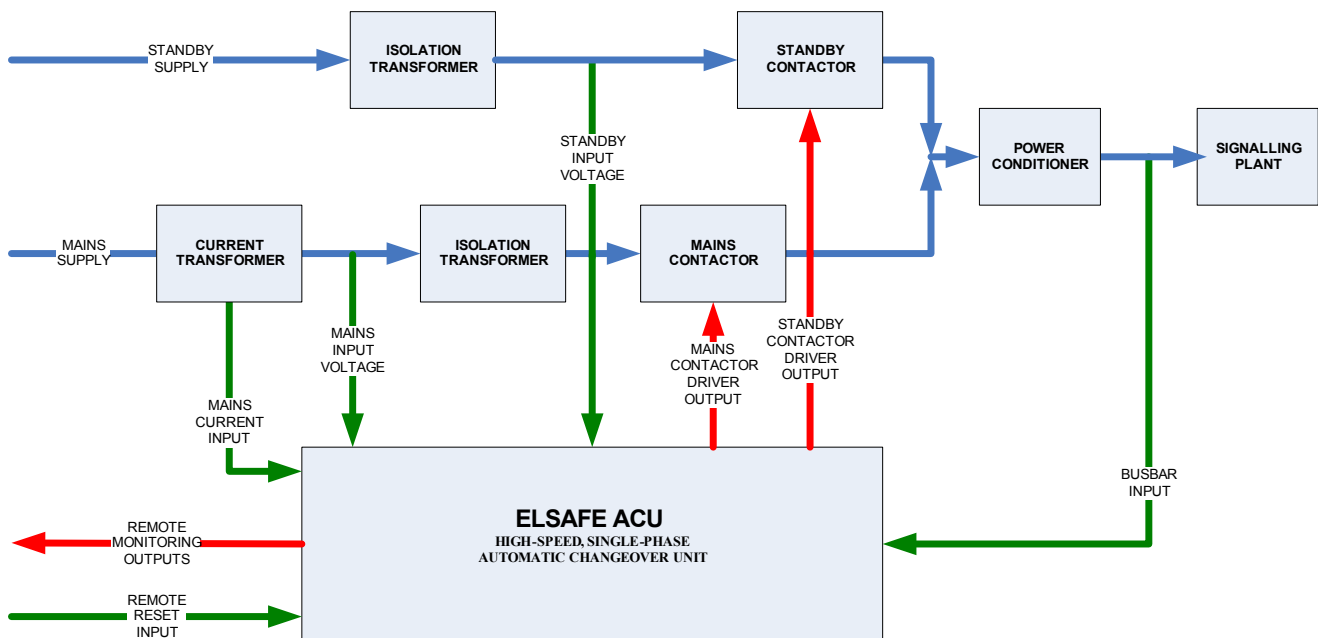
ACU SmartELogic Switching Diagram

An **external bypass switch** on the front panel allows a local operator to take control of the system away from the ACU and enable locking down to either Mains or Standby – particularly useful during servicing and maintenance.

The ACU also has a **backup watchdog system** that reacts to any abnormal system outputs scenarios. Once an abnormal system state is detected the local and remote alarms are set and as a precaution the Standby supply is switched through to the Mains. As an aid to system fault-finding, the Watchdog scenario can be identified by the flashing of seven dedicated internal LEDs.

A **Remote Facilities** plug allows monitoring by telemetry of the present states of the Mains, Standby and Busbar voltages as well as the operating state of the ACU in terms of which of the inputs is presently supplying the load. Signals indicating the states of the Watchdog alarm and an internal High Temperature alarm are also presented on the Remote Facilities plug.

## ACU Typical System Installation



Typical ACU System Installation

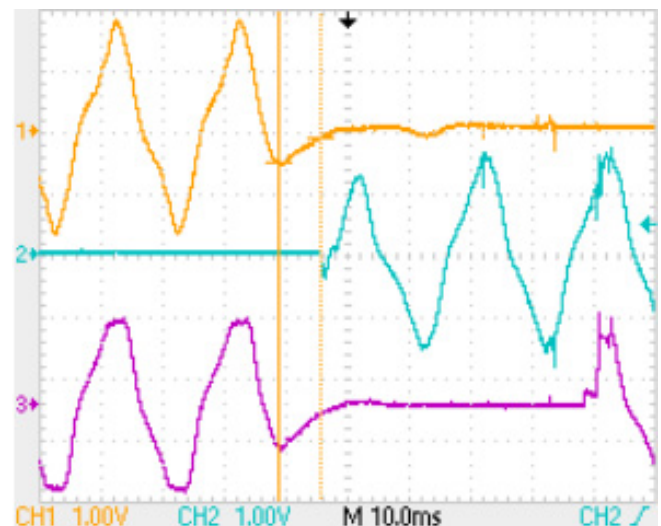
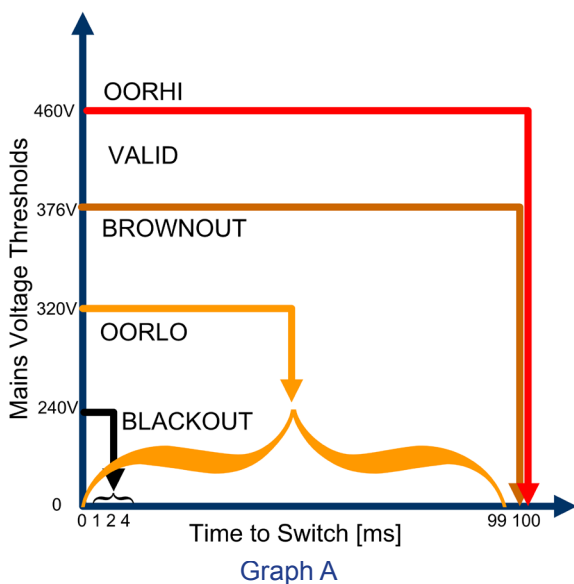
Shown in simplified block diagram form, the location of the ACU in relation to the surrounding equipment. Red lines indicate outputs from the ACU, green inputs, and blue are power supply lines.

# ACU Switching Times

Depending on the input voltage level and ACU configuration switching times will vary according to the “Graph A” and table below.

Out of Regulation - High Region (OORHI)	VOLTAGE LEVELS	TIMEOUTS
Mains voltage in this region is deemed too high for the long-term safe working of connected equipment	Above Valid Region	100ms, can be varied by a code change.
<b>Valid Region</b>		
This is the region in which the Mains voltage normally resides.	Upper and lower limits selectable.	Mains will stay in the valid region as long as the supply is within regulation limits.
<b>Brownout Region</b>		
This region is a buffer between the VALID and OORLO regions. Brownouts are common short-duration dips in supply voltage and the Mains voltage is allowed to drop temporarily into the Brownout region.	Below Valid, above 80% of preset value. Can be varied by code change.	100ms, can be varied by a code change.
<b>Out of Regulation - Low Region (OORLO)</b>		
Once Mains has fallen into this region, it may be expected to become lost altogether. However there is still some chance it will recover, so the ACU waits-out the Changeover delay before operating.	Below Brownout and above Blackout.	Field-selectable through the CHANGEOVER DELAY switch setting from 0 to 99ms.
<b>Blackout Region</b>		
Once in this region, Mains is deemed to have no chance of recovery, so the ACU operates at its quickest, as is the case when the Mains current falls below its threshold.	60% of preset level.	Internally selected between 1 and 4ms.

The actual switching signals are shown in the “Graph B”. The drive signal to the **Mains contactor is shown in yellow**, the drive signal to the **Standby contactor is shown in blue** and the **contactor output (Busbar) is shown in purple**. In this example the Mains power is lost and the ACU acts to drive the standby contactor in 6.8ms. The external fully interlocked contactor switches over and the output Busbar voltage is only lost for around 45ms. Note: These timings will depend on exact electrical setup, position in the ac voltage signal when the power is lost, and the choice of contactors etc.



# Benefits of the ACU over an Emergency Changeover (ECO) Panel

- Consistent, predictable, and settable changeover times.
- Multi Input SmartELogic decision logic is purpose built and designed for the rail industry incorporating inputs from:
  - o Main Frequency and Phase
  - o Mains Voltage Level
  - o Mains Current Level
  - o Standby (Emergency Supply) Voltage Level
  - o Current State and situation
- Hotspot detector to stop constant switching between Mains and Standby if there is a 'high resistance' fault.
- Watchdog feature to detect failures in system including the contactors.
- Ability to have remote monitoring for supply quality and state.
- Ability to manually operate the ACU to switch between Mains and Standby when servicing is required.
- Developed specifically for and with the railway industry – proven railway track record.
- Can be used with power conditioner.

## Example Situations:

- If the voltage swells and rises above safe limits on the Mains Supply an ECO panel will remain connected to that supply whereas the ACU will swap supplies – actively protecting equipment.
- An ECO panel could change supplies at a rate determined by the voltage level and the connected equipment – producing uncertainty and unpredictability.
- Logged tests at Queensland Rail have shown current and frequency/phase measurements to be advanced predictors of supplies failing, meaning that the ACU will switch even before the Mains voltage level is out of regulation.
- The ACU's SmartELogic takes into account real life practicalities, for example the ACU will not changeover supplies in the case where the Mains supply is at the brownout level, if there is an invalid Standby Voltage.

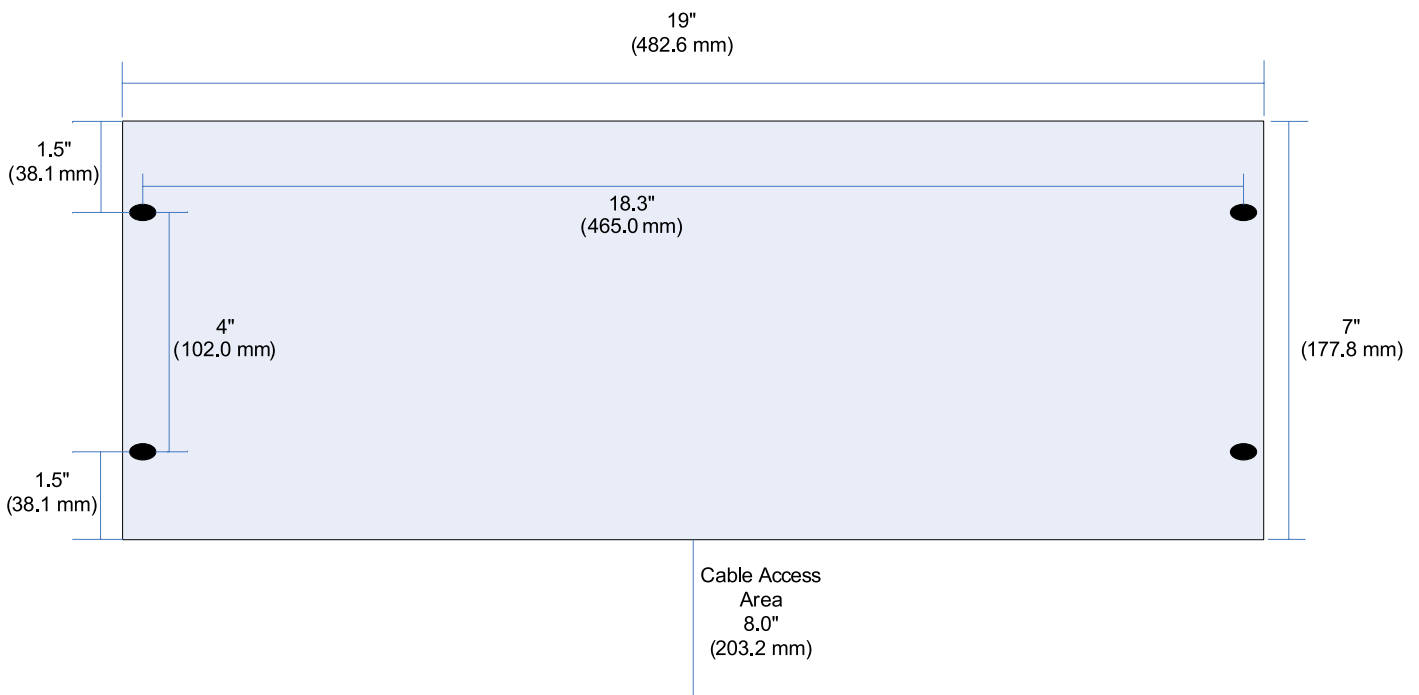
# ACU Specifications

Electrical Specification	
Nominal Single-Phase Input Voltages	230Vrms or 400Vrms (Can be factory configured to other voltages e.g. 120v)
Input Frequency	50Hz or 60Hz
Input Voltage Regulation Limits	Upper: +10%, +15%, +20%, +30% (internally field-selectable) Lower: -6%, -10%, -20%, -30% (internally field-selectable)
Minimum Brownout Voltage	80% of Nominal Input Voltage (fixed in memory)
Nominal Blackout Voltage	60% of Nominal Input Voltage (fixed in memory)
Maximum Controller Sub-rack power loading	20W
Non-polarised Remote Facilities Outputs	Withstand voltage rating 350Vrms Maximum load current rating 60mA
Non-polarised Remote Reset Input	Input terminating resistance 600Ω Maximum absolute input voltage 55V

System Timing Specification	
Maximum invalid Mains detection time	≤6ms (50Hz supplies), ≤5ms (60Hz supplies)
ACU system latency	≤ 4ms
Changeover delay time setting	1 to 99ms
Change back delay time setting	1 to 99 seconds or 10 to 990 seconds (selectable)
Absolute delay time setting accuracy	≤150ppm
Worst-case ACU changeover time	11ms (50Hz), 10ms (60Hz)

Physical Specification	
Operating Ambient Temperature Range	-20 to +50°C
Operating Ambient Relative Humidity	≤90%
Weight	11kg
Overall maximum dimensions	Width 483mm (19") Height 150mm (including uncoupled fixed connectors) Depth 335mm (including front panel handles)

Additional Features	
Watchdog System	Should there be an internal fault, or anomaly, between the ACU and contactors that should not occur during normal operating conditions, there is an internal watchdog that is wired to react automatically and activate the Standby contactor. The watchdog system helps to categorise the fault by displaying one of seven visual internal LEDs.
Hotspot Detector	There is a 'hotspot' detector to stop the ACU getting into a situation where it continually switches between Mains and Standby when there is a high resistance fault on the Mains supply line. The ACU will switch four times before permanently switching to Standby.
Remote Indicators	Seven indicators that detail the current state of the ACU are available on the Front Panel and through an external connector for remote system monitoring. It is also possible to remotely reset the unit.
Configurability	As the ACU is custom made, the internal firmware and switching logic can be modified to suits the clients installation needs.



**ACU Mounting Diagram**

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