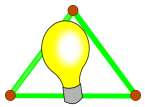
Open DC Grid Project

2020 June



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Agenda

- DC Grid Topologies – Martin
- DC Wiring for Homes
- Related Standards / Industry Developments
- Next Meeting / Feedback

DC Wiring for Homes
In the context of small SHSs (< 60V)

* Current focus on SHS installations
* Future integration with conventional AC

Jim's House

Azuri Indigo 2

DC Wiring for Homes?

Is there utility to permanent DC wiring in homes?

* NO?
  * Why invest in wiring when no stable DC standard exists?
  * Ethernet, USB standards exist but still changing rapidly
* Yes?
  * Cost
    * DC wiring can cost significantly less than AC ***
    * Installation lower cost via unlicensed technicians
  * Safety
    * DC wiring at < 60V is significantly less dangerous than AC
  * Efficiency?
    * Often argued that DC-DC is less expensive than AC-DC
    * Evidence weak: often depends on state of art DC versus old style AC

DC Home Wiring – Existing Standards

* IEC 60364 and US NEC include DC wiring requirements
  * Focus on industrial uses and PV
  * Focus on > 60V
  * No standard for connectors
* P2030.10.1 (draft) – 48V
  * No standard for connectors
* DC distribution for buildings and lighting
  * EMerge
  * POE lighting – many vendor standards
    * ANSI C137.3-2017 – POE minimum requirements
    * Approved for UL924 emergency lighting systems
  * DLC (designlights.org) lighting functionality standards
* USB/USB-C – de facto standard for DC appliances
* Power over Ethernet de facto standard for cameras
* Others?

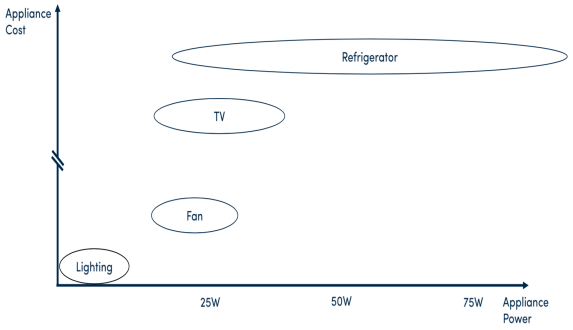
DC Home Wiring – Issues

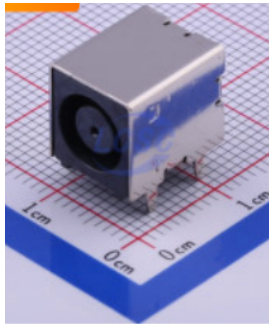
* Appliances: cords, sockets or screw terminals?
  * Exposed terminals => regulatory issues
  * Unidirectional versus bidirectional (appliances with batteries)
* Direct attach to SHS versus wired branches
  * Point of use converter such as USB or 48v -> 12V DC-DC?
* Wiring: pre-assembled cables versus ad-hoc
  * Wire gauge / current capacity
  * Colors
  * Stranded versus solid
  * Fire rating
* Conduit: required? useful?
* Earthing (Grounding): IT (isolated) vrs TN-C (1 pole earthed)
* Light switches: smart or dumb? how to switch USB-C?
* Connectors: USB versus barrel
  * Connector cost similar but USB-PD electronics still expensive

DC Home Wiring – GOGLA Discussions

Connector for 12V Applications

* GOGLA trying to standardize 12V connector
* Domestic use SHS <= 350W
* Optional communications

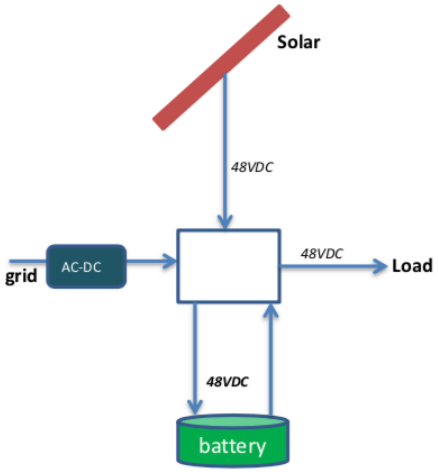


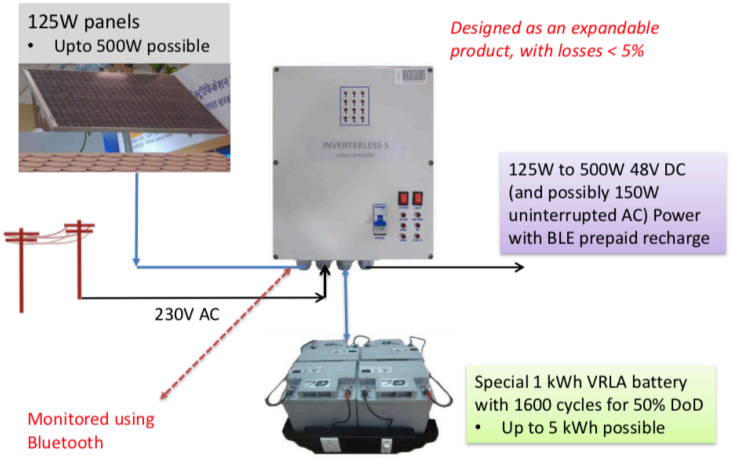


CUI PJ-096H: 8A, 25V, 3 poles

Dell 180W, 19.5V 7.4mm

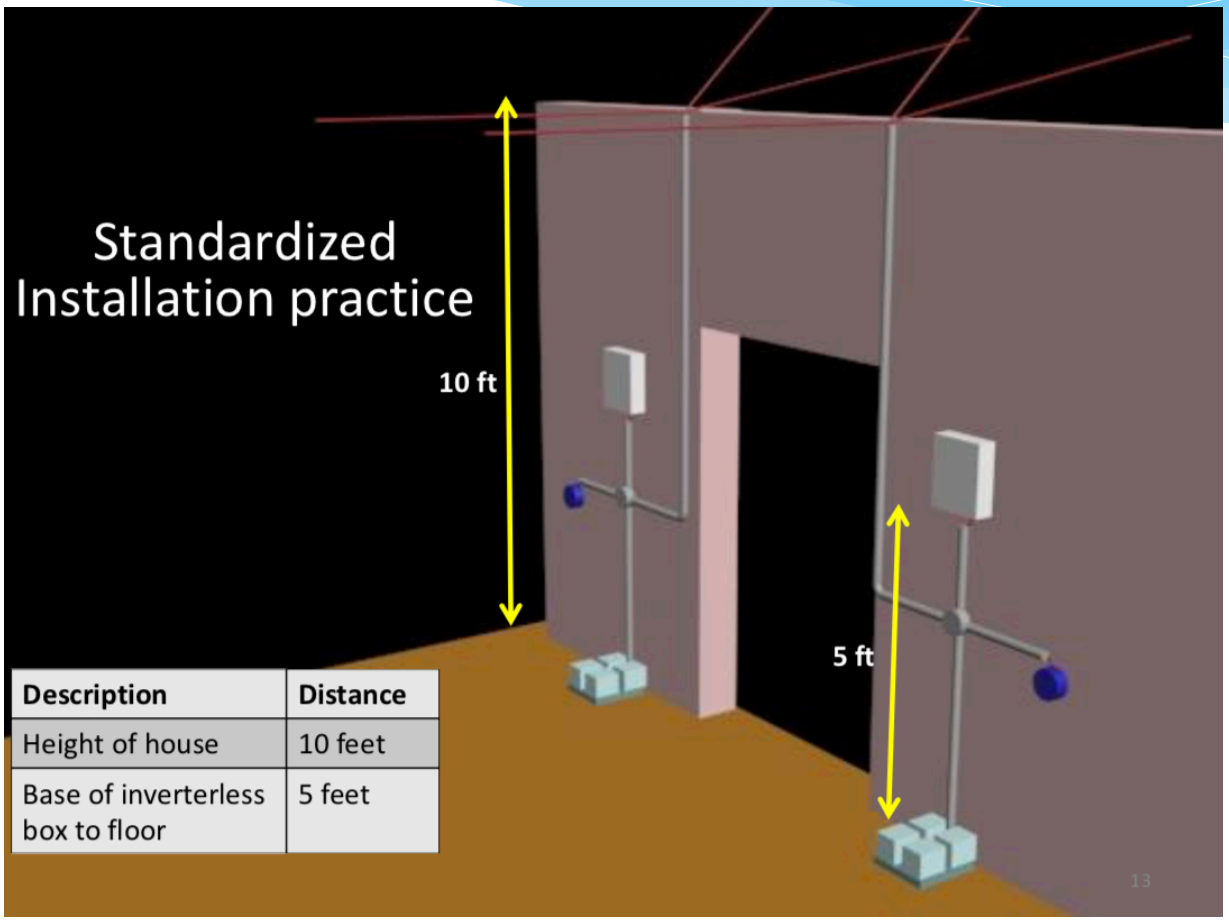
DC Home Wiring
India IEC SEG4 Architecture





* Both polarities isolated from earth
* 48V 4A branch circuits +/- 5V
* Surge and over voltage protection
* Dry conditions
* Linear loads for source DC-DC stability
* No arc fault prevention: at 48V 4A “arc sustenance is not possible”?

DC Home Wiring
India IEC SEG4 Installation Practice



Description	Distance
Height of house	10 feet
Base of inverterless box to floor	5 feet

DC Home Wiring
24V Class II Wiring

CLASS II DC WIRING SYSTEMS

NexTek example

Class 2, DC wiring can be accomplished with very simple **2 conductor** wiring and does **NOT** need to be in protective conduit or MC cable. This allows for very fast and simple 'plug-and-play' installation. PhD channel connectors and luminaire disconnects are commercially available.

For cable lengths less than 40ft., 12 AWG conductor wire is used. For cable lengths between 40ft and 70 ft, 10 AWG conductor wire is recommended.

* Class II is NEC article 725 class 2
  * < 30V DC, < 100 VA
  * Appropriate fireproofing required

DC Home Wiring – Thought Experiment

How to power 100W appliance from SHS?

* Options to consider:
  * 12V source – 12V (8A) appliance with barrel connector
  * 12V source – USB-C (20V, 5A) appliance
  * 48V source – 12V (8A) appliance with wall adapter
  * 48V source – USB-C (20V, 5A) appliance
  * 48V source – 48V (2A) appliance with TBD connector or screw terminals
  * USB-C source (20V, 5A) – USB-C appliance
  * POE source – POE (48V 2A) Appliance
* Issues
  * Cost – what is the total material cost between battery and appliance
  * AHJ regulations
  * Installation flexibility / technician skills required
  * Design complexity
* Observations
  * 48V – 12V 8A DC-DC BOM cost $5.53 (TI Webench)
  * 10.5 – 15V input 20V 5A output (USB-C) BOM cost $3.26 (TI Webench)
  * For 2.4V IR drop @ 8A (0.15 ohm) 2mm wire (#12AWG) can be 29 m

Related Standards / Industry Developments

* P2030.10
  * In review by PE/T&D
* P2030.10.1
  * Released D02

Next Meeting / Feedback

* Next Meeting
  * 14 July 2020 – 1400 UTC
  * FreeConferenceCall.com meeting ID: jlgula
* Sharing Portals
  * Web site: https://open-dc-grid.org/
  * GitHub: https://github.com/open-dc-grid
* Feedback?