Designing a **DC String Combiner Box (DCDB)** configuration for central inverter–based large-scale PV systems is a key engineering task. It involves aggregating several PV strings and feeding them into limited high-power DC inputs on the inverter. This process requires electrical safety, reliability, and compatibility with all components.

Let's break this down into **theoretical logic**, **step-by-step design methodology**, and **BOQ component sizing logic**.

✅ OVERVIEW: What is a DCDB?

A **DC Combiner Box (DCDB)**:

- Combines multiple PV strings (each with DC voltage and current) into one or more outgoing DC feeds.
- Includes **fuses, SPD, MCB/Isolator**, and internal wiring to protect and organize the DC circuits.
- Used mostly with **central inverters** or **string inverters with few DC inputs**.

⚙️ THEORETICAL LOGIC FOR SIZING DCDBs

🧠 Design Considerations:

Parameter	Description
No. of strings	Total strings from PV array
Inverter inputs	No. of DC inputs on inverter
Max strings per input	Depends on inverter input current
DCDB capacity	No. of string inputs per DCDB
Rated voltage	Based on system voltage (1000V / 1500V)
String current	Based on Isc of module and design factor
Protection	Overcurrent (fuses), surge (SPD), isolation (MCB/Isolator)

🧭 STEP-BY-STEP DESIGN METHOD

🔹 Step 1: Gather Inputs

- Module specs: Isc, Voc, Vmp
- No. of modules per string: e.g., 18
- No. of total strings per sub-array

- Inverter rated DC input voltage and max input current
- Number of DC inputs per inverter
- Site ambient temp (to adjust current rating)

🔹 **Step 2: Determine No. of Strings per Inverter**

Example:

- Central Inverter = 2.5 MW
- String: 550W × 18 modules = 9.9 kW
- Total strings: 2,500,000 / 9,900 ≈ 253 strings

🔹 **Step 3: Decide No. of Strings per DCDB**

Common practice:

- 12, 16, 20, 24 strings per DCDB (depends on enclosure size and bus bar rating)
- Based on standard practice and current load per string

Formula:

No. of DCDBs = Total Strings / Strings per DCDB

E.g., 253 strings ÷ 16 strings/DCDB ≈ **16 DCDBs**

🔹 **Step 4: DCDB Output Cable Sizing**

Each DCDB combines string inputs into one or two outgoing DC cables:

- Output current = Isc × No. of strings × 1.25 (safety factor)
- Size cable accordingly (e.g., 70/95/120 mm² DC cable)

🔹 **Step 5: Allocate DCDBs to Inverter Inputs**

If inverter has:

- 8 DC inputs
- You have 16 DCDBs
  → Use **Y-connectors** to combine 2 DCDBs per input (total 8 Y-connectors)

Alternative: Use 2-core output (positive/negative busbar) per DCDB, and route them to DC junction or LV DC panel before inverter.

🧰 DETAILED COMPONENT-WISE BOQ ESTIMATION LOGIC

🔸 1. DCDB Enclosure

- IP65/66 rated outdoor/indoor enclosure (polycarbonate or metallic)
- Size based on number of string inputs (e.g., 16 string inputs = 16× fuse holders, terminal blocks, SPD, etc.)
- Confirm cable entry/exit knockouts.

🔸 2. DC Fuses

- Fuse per string on +ve side (sometimes also on -ve side)
- Rated for 1.25 × Isc × derating (temp)
- Voltage rating ≥ system voltage (e.g., 1000VDC/1500VDC)
- Type: gPV fuses (solar-specific)

Quantity = No. of strings per DCDB

🔸 3. Fuse Holders

- Match the fuse format (e.g., 10×38mm)
- DIN rail–mountable
- Voltage rating same as fuse

Quantity = Same as DC fuses

🔸 4. DC SPD (Surge Protection Device)

- Type 2 SPD (DC, 1000V or 1500V)
- Protects inverter against overvoltage due to lightning or surge
- Normally 1 SPD per pole (L+/L−)

Per DCDB: 2 SPDs

🔸 5. DC MCB/Isolator

- DC-rated isolator (manual switch)
- Placed at the output of the combiner box
- Breaks both poles (+/-) during maintenance

1 per DCDB

🔸 **6. Bus Bars (DC Positive & Negative)**

- Copper busbars for internal string aggregation
- Rated for:
- Ibusbar = Isc × N_strings × 1.25 × temp derating
- Insulated and mounted with busbar supports

1 +ve and 1 -ve busbar per DCDB

🔸 **7. DC Terminals**

- For string input cable terminations
- Screw/spring clamp terminals
- 4 mm² to 6 mm² for input, 25–120 mm² for output

Quantity = 2 × No. of strings per DCDB (for + and –)

🔸 **8. Y-Connectors**

- If two DCDBs feed into a single inverter DC input
- Must be rated for combined current of both DCDBs
- MC4-type, T-type connectors

Quantity = No. of Inverter DC Inputs × 1
(If combining two DCDBs per input)

📜 **SAMPLE CALCULATION**

Assume:

- 253 strings, 2.5MW plant, 550W modules
- 1500VDC system, Isc per string = 14A
- Strings per DCDB = 16

Then:

- No. of DCDBs = 253 / 16 ≈ **16 DCDBs**
- Each DCDB has:
    - 16 × Fuses + 16 × Holders

    - 1 × SPD (2P)
    - 1 × DC Isolator
    - 2 × Busbars (positive/negative)
    - 32 × DC terminals (for 16 strings, + and −)
    - 1 × DC Enclosure
- If inverter has 8 DC inputs → **8 × Y-connectors**

✅ **FINAL TIP**

Use this structure to tabulate your BOQ in Excel:

Component	Unit	Qty per DCDB	Total DCDBs	Total Qty
DC Fuse (14A, 1500V)	Nos	16	16	256
Fuse Holder	Nos	16	16	256
SPD (Type 2, 1500V)	Nos	1	16	16
DC Isolator	Nos	1	16	16
Busbars (Cu)	Set	1	16	16
DC Enclosure	Nos	1	16	16
DC Terminals	Nos	32	16	512
Y-Connectors (2:1)	Nos	–	–	8
