Pre-Commissioning Process for CHINT Meters

Document Information

- **Version**: 1.0
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- **Target Audience**: Field Operations Team, Development Team, Remote Commissioning Team

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Introduction

Purpose of Pre-Commissioning

Pre-commissioning is the process of converting CHINT DDSU666/DTSU666 meters from their native **DL/T645 protocol** to **Modbus RTU protocol** and assigning unique Modbus addresses **before** the meters are installed at customer sites.

Why Pre-Commissioning Matters

Problem: Fresh CHINT meters operate on the Chinese DL/T645 protocol and default to Modbus address `1` after conversion. If meters are converted on-site:

- **Address collisions** occur when multiple meters default to address 1
- **Production disruption** happens when using the production USB-RS485 adapter for conversion (interrupts live meters)
- **Field complexity** increases with protocol conversion and addressing at customer locations

Solution: Pre-commission all meters in a controlled lab environment before field deployment.

Benefits

 Zero Downtime: Field installation becomes plug-and-play (physical connection only) **No Address Conflicts**: Each meter arrives with unique, pre-assigned Modbus address **Quality Control**: Test meter communication before shipping **Simplified Installation**: Field team doesn't need protocol conversion tools **Audit Trail**: Complete inventory tracking from procurement to commissioning

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Team Roles and Responsibilities

Development Team

Responsibilities:

- Assign Modbus addresses based on site requirements and numbering scheme
- Maintain master meter inventory spreadsheet
- Build and distribute converter.exe updates
- Provide escalation support for complex technical issues
- Plan and design system upgrades

Tools Used:

- Master Inventory Spreadsheet (Nextcloud Sheets)
- PyInstaller (for building Windows executable)

Field Operations Team

Responsibilities:

- Execute lab conversion of meters from DL/T645 → Modbus RTU
- Assign Modbus addresses per Development Team's mapping
- Test meter responses after conversion
- Update inventory status (Assigned → Converted → Shipped)
- Label meters physically with assigned Modbus address
- Package and ship pre-configured meters to sites

Tools Used:

- converter.exe (Windows GUI application)
- USB-RS485 adapter (dedicated lab adapter, NOT production)
- Meter Inventory Spreadsheet (Nextcloud Sheets)
- Physical label maker/stickers

Training Required:

- Converter tool operation (see Converter Tool Guide)
- Inventory management workflow
- Basic RS485 wiring (A+/B- terminals)

Field Installation Team

Responsibilities:

- Mount meter at customer location
- Wire power connections (L1/L2/L3/N)
- Wire current transformers (if three-phase meter)
- Connect to existing Modbus RS485 bus (A+/B- terminals)
- Verify meter powers up and displays readings
- Notify Remote Commissioning Team when installation complete

Tools Used:

- Standard electrical installation tools
- Multimeter for continuity checks

Training Required:

- Meter mounting procedures
- RS485 bus connection (parallel wiring to existing meters)
- Safety protocols for live electrical work

Remote Commissioning Team

Responsibilities:

- Connect to Raspberry Pi remotely via ZeroTier + SSH
- Add meter entry to production config file (config.prod.yaml)
- Deploy configuration changes using automated script
- Monitor service restart and verify meter logging
- Update inventory status (Installed → Commissioned)
- Notify stakeholders when meter is live

Tools Used:

- ZeroTier VPN client
- SSH client (Terminal, PuTTY, etc.)
- Text editor (nano, vim)
- add_meter.sh CLI helper script (recommended)

Training Required:

- SSH basics and remote access
- YAML syntax for meter configuration
- Deployment script usage
- Log monitoring with systemctl/journalctl

Equipment and Software Requirements

Hardware (Field Operations Team)

Item	Specification	Purpose	Notes
USB-RS485 Adapter	CH340, FTDI, or PL2303 chipset	Connect Windows PC to meter	**CRITICAL**: Use dedicated lab adapter, NOT production adapter
Windows PC/Laptop	Windows 7/10/11	Run converter.exe GUI	Must have USB port
Power Supply	230V AC (single-phase) or 3-phase	Power meter during conversion	Match meter type
RS485 Wiring	2-wire twisted pair	Connect adapter to meter A+/B- terminals	Keep wiring short (<2 meters)
Label Maker	Any type	Create Modbus address labels	Physical labels prevent confusion

Software (Field Operations Team)

Item	Location	Version	Purpose
converter.exe	Nextcloud: `/Field_Operations/Tools/converter_v1.0.exe`	v1.0	Protocol conversion and address assignment
USB Driver	Manufacturer website	Latest	CH340/FTDI/PL2303 driver for Windows
Meter Inventory	Nextcloud Sheets (shared link) + Excel backup on Nextcloud	Current	Track meter status

Download Links:

- CH340 Driver: http://www.wch.cn/downloads/CH341SER_EXE.html
- FTDI Driver: https://ftdichip.com/drivers/vcp-drivers/
- PL2303 Driver: http://www.prolific.com.tw/US/ShowProduct.aspx?p_id=225

Pre-Commissioning Workflow

Overview: 5-Phase Process

```
Phase 1: Address Assignment (Development Team)
   ↓
Phase 2: Lab Conversion (Field Operations Team)
   ↓
Phase 3: Pre-Dispatch Testing (Field Operations Team)
   ↓
Phase 4: Field Installation (Field Installation Team)
   ↓
Phase 5: Remote Commissioning (Remote Commissioning Team)
```

Phase 1: Address Assignment (Development Team)

Duration: 15-30 minutes per batch

Steps:

1. **Receive Procurement List**
   - New meters arrive from supplier
   - Record 12-digit serial numbers from meter labels
   - Note meter types (DDSU666 single-phase or DTSU666 three-phase)
2. **Assign Modbus Addresses**
   - Follow numbering scheme:
     - **Single-phase (DDSU666)**: IDs `02` to `99` (90 meters max per site)
     - **Three-phase (DTSU666)**: IDs `100` and above (unlimited)
   - **CRITICAL RULE**: Never use address `1` (factory default, causes conflicts)

   Example Assignment:

   ```
   Site: Office Building A
   - Meter Serial 200322016690 → Address 02 (Floor 1 Reception)
   - Meter Serial 200322016691 → Address 03 (Floor 1 Office)
   - Meter Serial 200322016692 → Address 04 (Floor 2 Office)
   - Meter Serial 200415023456 → Address 100 (Main 3-Phase Supply)
   ```

3. **Update Master Inventory Spreadsheet**
   - Open Nextcloud Sheets inventory (link in team resources)
   - Add new rows for each meter:
     - Meter Serial Number (12 digits)
     - Meter Type (DDSU666 or DTSU666)
     - Site Name
     - Building/Customer Name
     - Assigned Modbus Address
     - Status: **"Assigned"**
     - Date Assigned: Today's date
     - Assigned By: Your name
4. **Send Assignment List to Field Operations Team**
   - Export assignment list as PDF or share Nextcloud Sheets link
   - Include any special instructions (e.g., priority meters, site notes)

Phase 2: Lab Conversion (Field Operations Team)

Duration: 5-10 minutes per meter **Location**: Lab/Office environment **Tools**: Windows PC, converter.exe, USB-RS485 adapter

Steps:

2.1 Physical Setup

1. **Connect Meter to Power**
   - Single-phase: Connect L (live) and N (neutral)
   - Three-phase: Connect L1, L2, L3, and N
   - Verify meter LCD powers on and displays readings
2. **Connect USB-RS485 Adapter**
   - Locate meter's RS485 terminals (usually labeled A+/B- or 485A/485B)
   - Connect adapter's A+ wire to meter's A+ terminal
   - Connect adapter's B- wire to meter's B- terminal
   - **Polarity matters!** Incorrect wiring causes "No response" errors
3. **Connect Adapter to Windows PC**
   - Plug USB end into PC USB port
   - Windows should detect and install driver automatically
   - If not, install driver manually (see Equipment section)

2.2 Launch Converter Tool

1. **Run converter.exe**
   - Double-click converter_v1.0.exe from Nextcloud download
   - GUI window opens with title "DLT645 to Modbus Converter"
   - Initial status shows red "● Disconnected"

2.3 Configure Connection

1. **Detect Serial Port**
   - Click "⟳ Refresh" button
   - Dropdown populates with available ports (e.g., `COM3`, `COM4`)
   - If no ports appear:
     - Check USB cable connection
     - Verify driver installed (Windows Device Manager → Ports)
     - Try different USB port
2. **Select Port and Baud Rate**
   - Select detected port from dropdown (e.g., `COM3`)
   - Baud rate: Keep default `2400` (DLT645 standard)
3. **Connect to Port**
   - Click "Connect" button
   - Status changes to green "● Connected"
   - All action buttons become enabled
   - Log shows: `[HH:MM:SS] Connected → COM3 @ 2400 baud`

2.4 Enter Meter Details

1. **DLT645 Station Address** (12 digits)
   - Find on meter label or LCD display
   - Example: `200322016690`
   - Must be exactly 12 digits (tool validates)
2. **Target Modbus Address** (from assignment list)
   - Refer to Master Inventory for assigned address

- Example: Address `02` for first single-phase meter
- Valid range: 1-247 (but avoid address 1)

3. **Reverse Address Bytes** (checkbox)
   - Keep checked by default
   - Tool will auto-retry with this toggled if conversion fails

2.5 Execute Conversion (Recommended: Use "Full Process")

Option A: Full Process (Recommended for Field Operations)

1. Click "▶ Full Process" button
2. Tool automatically performs:
   - **Step 1/2**: Convert protocol (DLT645 → Modbus RTU)
   - **Step 2/2**: Change Modbus address to target value
3. Watch log panel for progress:

```
[14:23:15] ═══ Full Process Started ═══
[14:23:15] [1/2] Converting protocol — station=200322016690
[14:23:15] TX: FE FE FE FE 68 02 03 20 01 66 90...
[14:23:27] ✓ Protocol conversion done.
[14:23:27] [2/2] Changing Modbus address: 1 → 10
[14:23:30] ✓ Address set to 10.
[14:23:30] ═══ Full Process Complete ═══
```

4. **Success indicators**:
   - ✓ checkmarks for both steps
   - No ✗ errors in log
   - "Full Process Complete" message

Option B: Manual Step-by-Step (for troubleshooting)

If Full Process fails, try manual steps:

1. **Convert Protocol First**
   - Click "Convert Protocol" button
   - Tool sends DLT645 protocol-switch command
   - Wait 2-5 minutes for meter to respond
   - Log shows: `✓ Protocol conversion done.`
2. **Scan for Current Address** (optional)
   - Click "□□ Scan" button
   - Tool tests all 247 Modbus addresses (takes ~90 seconds)
   - Log shows: `✓ Meter found at Modbus address 1`
   - "Current Modbus Address" field auto-updates
3. **Change Address**
   - Ensure "Current Modbus Address" is correct (usually 1 after conversion)
   - Enter "Target Modbus Address" (from assignment list)

- Click "Change Modbus Addr" button
- Log shows: `✓ Address changed to 10.`

2.6 Update Inventory

1. **Open Nextcloud Sheets Inventory**
2. **Find meter row** (search by serial number)
3. **Update fields**:
   - Status: Change "Assigned" → **"Converted"**
   - Date Converted: Today's date
   - Converted By: Your name
   - Notes: Add any issues encountered (e.g., "Required reverse byte toggle")

2.7 Label Meter Physically

1. **Create Label** (using label maker or sticker)
   - Text: `Modbus Address: 02` (use actual assigned address)
   - Include site name if space permits
2. **Affix Label to Meter**
   - Place on front panel or top cover
   - Ensure visible after installation
   - Prevents confusion during field installation

2.8 Disconnect and Repeat

1. **Disconnect from Meter**
   - Click "Disconnect" button in converter tool
   - Status returns to red "● Disconnected"
   - Unplug USB-RS485 adapter from PC
   - Disconnect adapter from meter terminals
   - Power off meter
2. **Repeat for Next Meter**
   - Proceed to next meter in batch
   - Follow steps 2.1-2.7 for each meter

Phase 3: Pre-Dispatch Testing (Field Operations Team)

Duration: 5 minutes per meter **Purpose**: Verify meter responds at assigned Modbus address before shipping

Steps:

1. **Setup Test Bus**

- Connect 2-3 converted meters to same RS485 bus
- Use twisted pair wiring (parallel connection)
- Ensure meters have different addresses (e.g., 10, 11, 12)

2. **Test Communication** (Manual Method)
   - Connect USB-RS485 adapter to test bus
   - Open converter tool
   - Change baud rate to `9600` (Modbus standard)
   - Use "Scan" function to detect meters
   - Verify each meter responds at its assigned address
3. **Alternative: Use NFE Test Script**
   - If Raspberry Pi available for testing
   - Copy test_modbus_read.py script to test Pi
   - Edit script to test specific meter ID
   - Run: `python3 test_modbus_read.py`
   - Verify readings returned (voltage, current, power)
4. **Record Test Results**
   - Update inventory spreadsheet:
     - Add checkmark or "Tested OK" in Notes column
     - If test fails, mark as "Retest Required" and escalate to Development Team
5. **Package for Shipping**
   - Power off meter
   - Ensure address label is visible
   - Package securely with protective materials
   - Include shipping label with site name

Phase 4: Field Installation (Field Installation Team)

Duration: 30-60 minutes per meter (excluding electrical prep) **Location**: Customer site **Safety**: Follow all electrical safety protocols

Steps:

4.1 Pre-Installation Checks

1. **Verify Meter Received**
   - Confirm meter serial number matches work order
   - Verify Modbus address label matches site plan
   - Inspect for shipping damage
2. **Review Site Plan**
   - Identify installation location
   - Locate existing Modbus RS485 bus terminals
   - Note power source (single-phase or three-phase)

4.2 Physical Installation

1. **Mount Meter** (per manufacturer instructions)
   - Use DIN rail mounting or wall mount bracket
   - Ensure meter is accessible for reading and maintenance
   - Keep away from excessive heat and moisture
2. **Wire Power Connections**
   Single-Phase (DDSU666):
   - Connect Line (L) from customer's circuit breaker
   - Connect Neutral (N) from customer's neutral bar
   - Verify polarity with multimeter

   Three-Phase (DTSU666):
   - Connect L1, L2, L3 from customer's supply
   - Connect Neutral (N) from neutral bar
   - If using current transformers (CTs):
     - Install CTs on each phase conductor
     - Connect CT secondaries to meter CT terminals (K1/L1, K2/L2, K3/L3)
     - Ensure CT orientation matches current flow direction
3. **Wire Modbus RS485 Bus**
   - **CRITICAL**: This step must NOT interrupt existing meters
   - Locate existing RS485 bus terminals (A+/B- or 485A/485B)
   - Connect new meter's A+ terminal to bus A+ (parallel)
   - Connect new meter's B- terminal to bus B- (parallel)
   - Use twisted pair cable (CAT5 or dedicated RS485 cable)
   - Keep total bus length under 1200 meters
   - Use 120Ω termination resistor if meter is at end of bus

4.3 Power-Up and Verify

1. **Energize Meter**
   - Turn on customer circuit breaker
   - Meter LCD should illuminate and display readings
   - Verify voltage readings match expected values (230V ±10% single-phase, 400V ±10% three-phase)
2. **Quick Communication Test** (Optional)
   - If laptop with converter tool available:
     - Connect USB-RS485 adapter to bus (parallel, don't disconnect existing)
     - Set baud rate to 9600
     - Use "Scan" to verify meter responds at assigned address
     - Disconnect adapter when done
   - If no laptop: Skip this step (Remote Commissioning Team will verify)
3. **Notify Remote Commissioning Team**
   - Send message: "Meter [Serial Number] installed at [Site Name], ready for commissioning"
   - Include photo of meter with label visible (for audit trail)
   - Update inventory:

- Status: "Converted" → **"Installed"**
- Date Installed: Today's date
- Installed By: Your name

Phase 5: Remote Commissioning (Remote Commissioning Team)

Duration: 10-15 minutes per meter **Location**: Remote (via ZeroTier VPN + SSH)

Prerequisites:

- Receive notification from Field Installation Team
- ZeroTier VPN client installed and connected to network ID: `2873fd00f2d70904`
- SSH access to production Raspberry Pi: `nfetestpi2@10.135.127.86`

Steps:

5.1 Connect to Raspberry Pi

1. **Start ZeroTier VPN**
   - Ensure ZeroTier client is running
   - Verify connected to "my-first-network" (ID: 2873fd00f2d70904)
   - Check ZeroTier shows "ONLINE" status
2. **SSH to Production Pi**

   ```
   ssh nfetestpi2@10.135.127.86
   ```

   - Enter password when prompted
   - Or use SSH key if configured (passwordless)

5.2 Add Meter to Configuration (Option A: Manual Edit)

For users comfortable with YAML editing:

1. **Edit Staging Config**

   ```
   nano ~/nfe-modbus-energy-logger/config/config.prod.yaml
   ```

2. **Add Meter Entry**
   Scroll to the `meters:` section and add new entry:
   Single-Phase Meter Example:

   ```
   meters:
     # ... existing meters ...
   ```

```
  - id: 2                       # Assigned Modbus address
    name: "floor1_reception"    # Descriptive name (lowercase, underscores)
    type: "1phase"              # Meter type
    enabled: true               # Enable logging
```

Three-Phase Meter Example:

```
meters:
  # ... existing meters ...

  - id: 100                     # Assigned Modbus address
    name: "main_supply"         # Descriptive name
    type: "3phase"              # Meter type
    enabled: true               # Enable logging
```

Naming Conventions:

- Use lowercase letters
- Use underscores instead of spaces
- Make names descriptive but concise
- Examples: `floor2_office`, `hvac_panel`, `server_room`

3. **Save and Exit**
   - Press `Ctrl+O` to save
   - Press `Enter` to confirm filename
   - Press `Ctrl+X` to exit nano

5.2 Add Meter to Configuration (Option B: CLI Helper Script - RECOMMENDED)

For automated validation and safety:

1. **Run Helper Script**

```
~/nfe-modbus-energy-logger-prod/scripts/add_meter.sh
```

2. **Answer Interactive Prompts**

```
Enter Meter ID (2-247): 2
Enter Meter Name: floor1_reception
Enter Meter Type (1phase/3phase): 1phase
Enable meter? (yes/no): yes

About to add:
  ID: 2
```

```
  Name: floor1_reception
  Type: 1phase
  Enabled: true

Proceed? (yes/no): yes
```

3. **Script Automatically**:
   - Validates input (address range, type, duplicate ID check)
   - Backs up current config
   - Appends meter to YAML
   - Runs deployment script
   - Monitors service restart
   - Verifies meter logging
   - Reports success or failure
4. **Review Output**

```
 Meter 2 (floor1_reception) successfully added and logging
Data directory: ~/nfe-modbus-energy-logger-prod/data/meter_010/
CSV file: meter_010_2026-04-04.csv
```

5.3 Deploy to Production (Manual Method Only)

Skip this if you used add_meter.sh script (already done)

1. **Run Deployment Script**

```
~/nfe-modbus-energy-logger/scripts/deploy.sh
```

2. **Script Actions**:
   - Backs up production directory
   - Syncs staging code to production
   - Runs pre-flight test (30-second dry run)
   - Restarts meter.service
   - Verifies service started successfully
   - Auto-rollback if service fails
3. **Monitor Deployment**
   - Watch for "Deployment complete" message
   - Check for any error messages
   - If errors occur, script auto-rolls back

5.4 Monitor Service Restart

1. **Watch Service Logs**

```
sudo journalctl -u meter.service -f
```

2. **Look for Meter Initialization**

```
[timestamp] □ Initialized meter 10 (floor1_reception, 1phase)
[timestamp] □□Starting multi-meter logger
[timestamp]    Poll interval: 10s
[timestamp]    Log interval: 900s (15 minutes)
[timestamp]    Active meters: 3
```

3. **Press `Ctrl+C` to stop watching logs**

5.5 Verify Meter Logging

1. **Check Data Directory Created**

```
ls -lh ~/nfe-modbus-energy-logger-prod/data/
```

   - Should show new directory: `meter_010/` (or corresponding ID)
2. **Check CSV File Started**

```
ls -lh ~/nfe-modbus-energy-logger-prod/data/meter_010/
```

   - Should show CSV file: `meter_010_2026-04-04.csv` (today's date)
3. **View Recent Log Entries**

```
tail -20 ~/nfe-modbus-energy-logger-prod/data/meter_010/meter_010_2026-04-04.csv
```

   - Should show recent readings with timestamps
   - Verify data fields populated (not all zeros or empty)
4. **Sample Output**:

```
timestamp,meter_id,V_L1_V,I_L1_A,P_total_kW,E_total_kWh,...
2026-04-04 15:15:00,10,234.5,2.1,0.49,12345.6,...
2026-04-04 15:30:00,10,235.1,2.3,0.53,12345.8,...
```

5.6 Update Inventory and Notify

1. **Update Inventory Spreadsheet**
   - Status: "Installed" → **"Commissioned"**
   - Date Commissioned: Today's date
   - Commissioned By: Your name
   - Notes: Add any observations (e.g., "All readings nominal")
2. **Verify Backup Enabled** (if configured)
   - Check backup service runs successfully:

     ```
     sudo journalctl -u backup.service -n 50
     ```

   - Verify meter CSV files being backed up to Nextcloud

3. **Notify Stakeholders**
   - Send confirmation message: "Meter [Serial Number] commissioned at [Site Name] - logging active"
   - Include link to meter data directory or dashboard (if available)

Converter Tool Guide

GUI Overview

```
┌──────────────────────────────────────────────────────────┐
│  DLT645 to Modbus Converter                              │
├──────────────────────────────────────────────────────────┤
│  Serial Port: [COM3         ▼] [□ Refresh]  [Connect]  │
│  Baud Rate:   [2400         ▼]                           │
│  Status: ● Connected                                     │
├──────────────────────────────────────────────────────────┤
│  DLT645 Station Address (12 digits):                     │
│  [200322016690                                      ]  │
│                                                          │
│  Current Modbus Address: [1   ]  [□□Scan]                │
│  Target Modbus Address:  [10  ]                          │
│                                                          │
│  ☑ Reverse address bytes                                 │
├──────────────────────────────────────────────────────────┤
│  [Convert Protocol] [Change Modbus Addr] [▶ Full Process]│
├──────────────────────────────────────────────────────────┤
│  Log Panel (scrollable):                                 │
│  [14:23:15] Connected → COM3 @ 2400 baud                 │
│  [14:23:25] Converting protocol — station=200322016690   │
│  [14:23:27] ✓ Protocol conversion done.                  │
│  [14:23:30] ✓ Address changed to 10.                     │
│                                                          │
└──────────────────────────────────────────────────────────┘
```

Input Field Descriptions

Field	Description	Valid Values	Example

Serial Port	USB-RS485 adapter COM port	Auto-detected ports	COM3
Baud Rate	Communication speed	1200, 2400, 4800, 9600, 19200	2400 (DLT645 default)
DLT645 Station Address	Meter's 12-digit serial number	000000000000 - 999999999999	200322016690
Current Modbus Address	Address meter currently responds to	1-247	1 (factory default)
Target Modbus Address	New address to assign	1-247	10 (from assignment list)
Reverse Address Bytes	Toggle byte order for firmware compatibility	Checked/Unchecked	☑ Checked (recommended)

Button Functions

Button	Function	When to Use	Duration
⟳ Refresh	Re-scan for serial ports	USB adapter just connected	Instant
Connect	Open selected serial port	Before any conversion operations	Instant
Disconnect	Close serial port	After conversion complete	Instant
Convert Protocol	Send DLT645 protocol-switch command	Standalone protocol conversion	2-5 minutes
◫ Scan	Search all 247 Modbus addresses	Find current meter address	~90 seconds
Change Modbus Addr	Write new address to meter	After protocol conversion	5-10 seconds
▶ Full Process	Automated conversion + address change	**RECOMMENDED for Field Operations**	5-10 minutes

Success Indicators

Look for these in the log panel:

✅ Protocol Conversion Success:

```
[14:23:27] ✓ Protocol conversion done.
```

✅ Address Change Success:

```
[14:23:30] ✓ Address set to 10.
```

✅ Full Process Success:

```
[14:23:30] ═══ Full Process Complete ═══
```

 Meter Discovery Success:

```
[14:23:45] ✓ Meter found at Modbus address 1. 'Current Modbus Address' updated.
```

Error Indicators

 Communication Errors:

```
[14:23:27] ✗ No response — check wiring / address / baud rate.
```

 Validation Errors:

```
Validation Error: Station address must be exactly 12 digits.
Validation Error: Modbus address must be an integer 1–247.
```

 Port Errors:

```
Error: No port selected. Click  Refresh first.
Connection Error: [SerialException message]
```

Troubleshooting Guide

Problem: No Serial Ports Detected

Symptoms:

- Dropdown shows "No ports found" or is empty
- "⟳ Refresh" button doesn't populate ports

Causes and Solutions:

1. **USB Adapter Not Connected**
   - **Solution**: Plug USB adapter into PC USB port
   - Click "⟳ Refresh" again
2. **Driver Not Installed**
   - **Solution**: Install USB-RS485 driver for your adapter chipset
   - Check Windows Device Manager → Ports (COM & LPT)
   - If device shows yellow warning icon, driver missing

- Download and install correct driver (see Equipment section)
- Restart PC if required
- Click "⟳ Refresh" after driver installed

3. **Faulty USB Cable or Adapter**
   - **Solution**: Try different USB port
   - Try different USB cable
   - Test adapter on another PC
   - Replace adapter if confirmed faulty
4. **Windows Security Blocking**
   - **Solution**: Run converter.exe as Administrator
   - Right-click → "Run as administrator"

Problem: "No Response" During Protocol Conversion

Symptoms:

- Log shows: `[HH:MM:SS] ✗ No response.`
- Tool retries with reverse byte toggle automatically

Causes and Solutions:

1. **Incorrect Station Address**
   - **Solution**: Double-check 12-digit serial number on meter label
   - Ensure no typos (easy to confuse 0/O, 1/l, 6/8)
   - Verify number matches meter (not packaging)
2. **Wiring Problem (Most Common)**
   - **Solution**: Check RS485 connections
   - Verify A+ to A+, B- to B- (not swapped)
   - Tighten terminal screws (loose connections cause intermittent failures)
   - Use twisted pair cable (not individual wires)
   - Keep wiring short (<2 meters)
3. **Incorrect Baud Rate**
   - **Solution**: Confirm baud rate is 2400 for DLT645 meters
   - Some meters may use different rates (try 1200, 4800)
4. **Meter Not Powered**
   - **Solution**: Verify meter LCD is illuminated
   - Check power connections (L/N for single-phase, L1/L2/L3/N for three-phase)
   - Use multimeter to verify voltage at terminals
5. **RS485 Bus Termination Issue**
   - **Solution**: If multiple meters on same bus, add 120Ω termination resistor across A+/B- at each end
6. **Reverse Byte Order Required**

- **Solution**: Tool auto-retries with reverse toggle
- Manually toggle "Reverse address bytes" checkbox and retry

7. **Meter Already in Modbus Mode**
   - **Solution**: Meter may already be converted (from previous attempt)
   - Change baud rate to 9600
   - Use "Scan" function to find current address
   - Skip to "Change Modbus Addr" step if needed

Problem: Scan Finds No Modbus Address

Symptoms:

- After protocol conversion, scan completes but finds no meter
- Log shows: `⚠ No meter responded on Modbus addresses 1-247.`

Causes and Solutions:

1. **Protocol Conversion Failed**
   - **Solution**: Meter still in DLT645 mode
   - Return to "Convert Protocol" step
   - Try manual conversion with longer timeout
   - Power cycle meter (turn off, wait 10 seconds, turn on)
   - Retry conversion
2. **Incorrect Baud Rate for Modbus**
   - **Solution**: After conversion, meter uses 9600 baud for Modbus
   - Change baud rate dropdown to 9600
   - Retry scan
3. **Meter Needs Time to Restart**
   - **Solution**: Wait 5 minutes after protocol conversion
   - Power cycle meter
   - Retry scan

Problem: Address Change Fails

Symptoms:

- Log shows: `✗ Address change failed.`
- Meter doesn't respond at new address

Causes and Solutions:

1. **Wrong Register Address for Meter Type**
   - **Solution**:

- DDSU666 (single-phase) uses register 0x0006
- DTSU666 (three-phase) uses register 0x002E
- Converter GUI currently supports single-phase only
- For three-phase, use CLI version:

```
python3 converter_cli.py change --port COM3 --current 1 --target 10 --type 3phase
```

2. **Meter Not in Modbus Mode**
   - **Solution**: Ensure protocol conversion succeeded first
   - Use "Scan" to verify meter responds in Modbus mode
3. **Current Address Incorrect**
   - **Solution**: Use "Scan" function to discover actual current address
   - Update "Current Modbus Address" field with scanned value
   - Retry address change

Problem: Meter Doesn't Respond After Conversion

Symptoms:

- Conversion appears successful in log
- But meter doesn't respond in Modbus mode later

Causes and Solutions:

1. **Conversion Incomplete (False Positive)**
   - **Solution**: Some meters acknowledge command but don't actually switch
   - Power cycle meter (off for 30 seconds, then on)
   - Wait 5 minutes after power-on
   - Retry scan
2. **Firmware Requires Extended Timing**
   - **Solution**: Use CLI version with extended timeout:

```
python3 converter_cli.py convert --port COM3 --station 200322016690 --reverse --extended
```

3. **Meter Reverted to DLT645 Mode**
   - **Solution**: Some meters revert to factory default after power loss
   - This is rare but possible
   - Repeat full conversion process
   - Test immediately after conversion before power cycling

Escalation: When to Contact Development Team

Contact Development Team if:

- Meter doesn't respond after 3 conversion attempts
- Error messages not covered in this guide
- Physical damage suspected (meter LCD dead, RS485 terminals broken)
- Firmware version incompatibility suspected
- Need CLI script for three-phase meter address change
- converter.exe crashes or freezes

Escalation Information to Provide:

- Meter serial number
- Meter type (DDSU666 or DTSU666)
- Complete log output from converter tool (screenshot)
- Steps already attempted
- Observations (LCD displays, unusual behavior)

Safety and Best Practices

General Safety

⚠ **Electrical Safety**:

- Only qualified electricians perform power wiring (Phase 4)
- De-energize circuits before connecting meter to live power
- Use lockout/tagout (LOTO) procedures
- Verify voltage with multimeter before assuming power is off
- Wear appropriate personal protective equipment (PPE)

⚠ **RS485 Bus Safety**:

- Never connect/disconnect RS485 wiring with power applied (can damage meter)
- Use ESD (electrostatic discharge) precautions when handling meter electronics
- Keep RS485 bus wiring away from high-voltage conductors (>50V)

Conversion Best Practices

 One Meter at a Time:

- Convert meters individually (don't connect multiple unconverted meters to same bus)
- This prevents address conflicts during conversion

 Document Before Converting:

- Update inventory BEFORE starting conversion
- Record meter serial number, type, and assigned address
- This prevents confusion if interrupted mid-process

 Test Before Shipping:

- Always perform Phase 3 Pre-Dispatch Testing
- Catch issues in lab, not at customer site
- Reduces field failures and rework

 Never Reuse Addresses on Same Site:

- Each meter must have unique address
- Keep site-specific address map
- Even if meter replaced, don't reuse old address immediately (wait until removed from config)

 Physical Labeling is Mandatory:

- Label prevents installation errors
- Field Installation Team relies on label (may not have inventory access)
- Use durable labels (water-resistant, doesn't fade)

 Keep Conversion Logs:

- Take screenshot of successful conversion log
- Store in Nextcloud or local folder
- Useful for audit trail and troubleshooting
- Include meter serial number in filename (e.g., `conversion_200322016690_success.png`)

Inventory Management

Master Inventory Spreadsheet

Primary Location: Nextcloud Sheets (shared link - request from Development Team) **Backup Location**: Nextcloud `/Field_Operations/Templates/METER_INVENTORY_TEMPLATE.xlsx`

Required Columns

Column Name	Data Type	Purpose	Example
Meter Serial Number	Text (12 digits)	Unique meter identifier	200322016690
Meter Type	Text	Single or three-phase	DDSU666 or DTSU666
Site Name	Text	Customer site	Office Building A
Building/Customer	Text	Specific location or customer name	Floor 1 Reception
Assigned Modbus Address	Number (1-247)	Pre-assigned unique address	10
Status	Dropdown	Current workflow stage	Assigned, Converted, Shipped, Installed, Commissioned
Date Assigned	Date	When address assigned	2026-04-01
Date Converted	Date	When protocol conversion completed	2026-04-02
Date Installed	Date	When physically installed at site	2026-04-03
Date Commissioned	Date	When added to NFE config and logging	2026-04-04
Converted By	Text	Field Ops team member name	Jane Doe
Installed By	Text	Field Installation team member	John Smith
Commissioned By	Text	Remote Commissioning team member	Alice Johnson
Notes	Text	Issues, observations, special instructions	Required reverse byte toggle

Status Workflow

```
Unassigned → Assigned → Converted → Shipped → Installed → Commissioned
     ↓          ↓           ↓           ↓          ↓            ↓
   (New)   (Dev Team)  (Field Ops) (Field Ops) (Field Inst) (Remote Comm)
```

Status Definitions:

- **Unassigned**: New meter received from supplier, no address assigned yet
- **Assigned**: Development Team assigned Modbus address, ready for conversion

- **Converted**: Field Operations Team completed protocol conversion and address assignment
- **Shipped**: Meter packaged and sent to customer site
- **Installed**: Field Installation Team physically installed meter and wired to bus
- **Commissioned**: Remote Commissioning Team added to NFE config and verified logging

Conditional Formatting (Nextcloud Sheets)

Setup in Nextcloud Sheets:

1. **Status Column Color Coding**:
   - Unassigned: Gray background
   - Assigned: Yellow background (action required by Field Ops)
   - Converted: Light blue (ready to ship)
   - Shipped: Blue (in transit)
   - Installed: Orange (action required by Remote Comm)
   - Commissioned: Green (complete)
2. **Overdue Highlighting**:
   - If "Status = Assigned" and "Date Assigned" > 7 days ago → Red text (conversion overdue)
   - If "Status = Installed" and "Date Installed" > 2 days ago → Red text (commissioning overdue)
3. **Address Range Validation**:
   - If "Meter Type = DDSU666" and "Assigned Modbus Address" < 10 or > 99 → Red background (invalid)
   - If "Meter Type = DTSU666" and "Assigned Modbus Address" < 100 → Red background (invalid)

Data Validation (Nextcloud Sheets)

Setup in Nextcloud Sheets:

1. **Status Dropdown**:
   - Column: Status
   - Criteria: List from a range: `Unassigned, Assigned, Converted, Shipped, Installed, Commissioned`
   - Reject invalid input
2. **Meter Type Dropdown**:
   - Column: Meter Type
   - Criteria: List from a range: `DDSU666, DTSU666`
   - Reject invalid input
3. **Address Range Validation**:
   - Column: Assigned Modbus Address
   - Criteria: Number between 1 and 247

- Warning on invalid input (not rejection, to allow temporary placeholders)

Audit Trail Requirements

What to Track:

- Every status change must include date and operator name
- Notes column should capture any deviations from standard process
- Conversion logs (screenshots) stored in Nextcloud with meter serial in filename

Retention:

- Keep inventory records for lifetime of deployment
- Archive old entries when meters decommissioned
- Export monthly backup to Excel and store in Nextcloud

Future Enhancements

Planned for Phase 2:

1. **Web-Based Commissioning Portal**
   - Browser-based UI for adding meters to NFE config
   - No SSH required for Remote Commissioning Team
   - Authentication and audit logging
   - Real-time dashboard showing meter status
2. **Automated Meter Discovery on Modbus Bus**
   - Raspberry Pi scans bus for new meters automatically
   - Suggests config entries for detected meters
   - Reduces manual configuration errors
3. **Inventory Management Database**
   - Centralized database replacing Nextcloud Sheets
   - API integration between converter tool and inventory
   - Auto-update status on successful conversions
   - Real-time sync across all teams
4. **Converter Tool Enhancements**:
   - Batch operations (convert multiple meters in sequence)
   - Save/load meter assignment lists
   - Auto-populate from inventory database
   - Persistent configuration (remember last settings)
   - Auto-generated conversion reports (PDF)
5. **Mobile App for Field Installation**
   - Scan meter barcode/QR code
   - Verify address label matches inventory

    - Guided installation checklist
    - Photo documentation for audit trail
6. **Automated Alerting**:
    - Notify Remote Commissioning when meter installed
    - Alert if meter stops logging after commissioning
    - Daily summary of meters pending action
7. **Fleet Management Dashboard**:
    - Web dashboard showing all meters across all sites
    - Real-time status (online/offline)
    - Energy consumption graphs
    - Maintenance scheduling

How to Request Features:

- Contact Development Team (CTO)
- Describe use case and priority
- Features prioritized based on team feedback and ROI

Appendix

Glossary

- **DL/T645**: Chinese national standard for electrical meter communication protocol
- **Modbus RTU**: Industry-standard serial communication protocol for industrial devices
- **RS485**: Differential serial communication standard (A+/B- or Data+/Data-)
- **Station Address**: 12-digit unique identifier for DL/T645 meters (meter serial number)
- **Modbus Slave Address**: 1-byte address (1-247) for Modbus devices on same bus
- **USB-RS485 Adapter**: Device converting USB to RS485 differential signals
- **Baud Rate**: Communication speed in bits per second (bps)
- **Protocol Conversion**: One-time operation switching meter from DL/T645 to Modbus mode
- **ZeroTier**: Virtual private network (VPN) software for secure remote access
- **SSH**: Secure Shell protocol for remote command-line access

Quick Reference Card

Converter Tool Quick Steps:

1. Connect meter power and USB-RS485 adapter
2. Run converter.exe → Refresh → Select port → Connect
3. Enter 12-digit station address (from meter label)
4. Enter target Modbus address (from inventory)

5. Click "▶ Full Process"
6. Wait for "✓ Full Process Complete"
7. Update inventory status to "Converted"
8. Label meter with address sticker

Common Mistakes to Avoid:

- □ Using address 1 (always use 10+ for single-phase, 100+ for three-phase)
- □ Swapping A+/B- wiring (causes "No response" errors)
- □ Forgetting to change baud rate to 9600 after conversion (for Modbus scan)
- □ Skipping physical label (causes installation errors)
- □ Not updating inventory (breaks audit trail)

Document Version History:

- v1.0 (2026-04-04): Initial release - Complete pre-commissioning workflow

Document Owner: Development Team **Review Cycle**: Quarterly or as needed for process updates

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