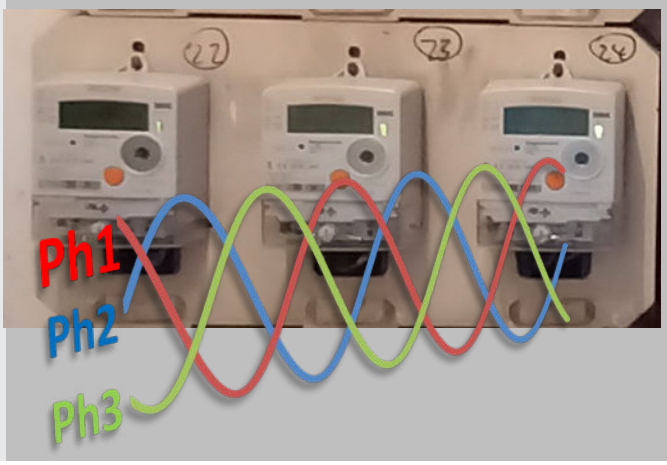
SUCCESS CASE 60.2025

Phase Detection in Meters using PRIME

PHASE DETECTION IN PRIME V1.4 NEW GENERATION METERS



THE CHALLENGE

In electrical installations supplied from three-phase transformer centers, each customer is typically connected to one of the three available phases (L1, L2, or L3). This distribution is essential for balancing the load across phases, optimizing system performance, and minimizing energy losses.

To ensure proper technical and operational management, it is crucial that electrical meters include phase detection capabilities. This feature allows precise identification of the phase to which each supply point is connected, offering several key benefits:

1. Load Balancing

Knowing the phase connection of each customer enables the system operator to redistribute loads efficiently, preventing overloading of any single phase and enhancing network stability. Unbalanced loads can cause overcurrent at the neutral conductor with different phase and neutral wire section.

2. Fault Diagnosis

In the event of a fault or voltage drop affecting a specific phase, phase detection allows for quick identification of impacted customers, speeding up technical response and minimizing service downtime.

3. Advanced Monitoring

Phase information helps correlate electrical events (such as voltage fluctuations, harmonics, or outages) with the affected phase, improving supply quality and analytical capabilities.

4. Traceability and Maintenance

During maintenance or network expansion, having phase data available in meters allows for more accurate planning, avoids connection errors, and supports traceability of field operations.

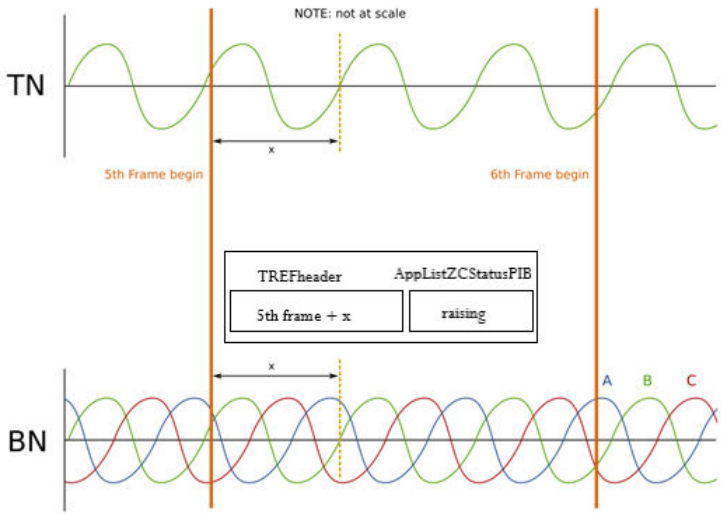
THE SOLUTION

PRIME 1.4 Connectivity: Phase Detection Integration

PRIME 1.4 connectivity includes phase detection integration for each Communication Node (CN) by coordinating the zero-crossing detection of the signal both at the headend (Base Node integrated in the Data Concentrator) and at each smart meter (Service Node within the PRIME topology). This coordination enables accurate identification of the phase to which each CN is connected.

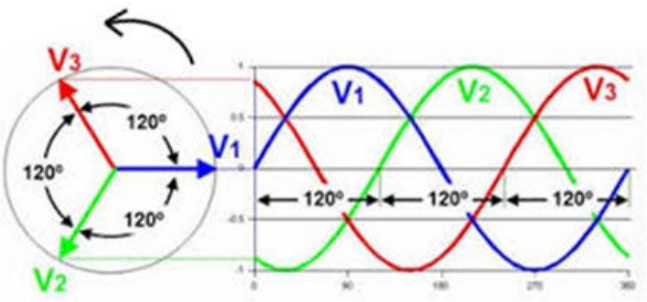
PLC TECHNOLOGY

It superimposes a high-frequency signal (telecommunications) onto the 50 Hz electrical waveform.



PLC PRIME

- Synchronous Protocol → The start time and duration of frames are propagated across the network via beacons, which are transmitted at fixed and known intervals, maintaining network synchronization with a unique time reference.
- Temporal Event → The zero-crossing time of the 50 Hz signal, relative to the frame start time.
- Each Service Node's response to the AppListZCStatus attribute in the PIB includes in TREF the timestamp of the 50 Hz signal's zero-crossing detected at the Service Node (SN).
- The Base Node (BN) converts this time interval into angular units (from 0º to 359.99º) relative to its own phase reference. This allows the BN to transmit the phase shift of each registered SN in angular units.
- Using this information, it is possible to associate the phase shift with the connection phase when the shift is close to 0°, 120°, or 240°.



MAIN ACHIEVEMENTS

Reliability

Correct phase calculation for 100% of PRIME v1.4 Communication Nodes (CNs).

Accuracy

The maximum deviation observed in the angle is 24° in single-phase CNs, well below the maximum allowable threshold of ±60°.

Speed

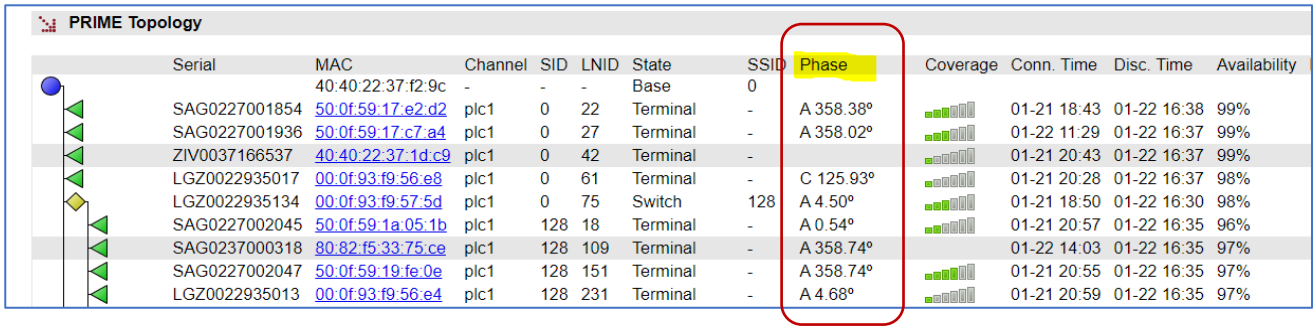
Less than 5 minutes required to process 100 CNs.

Interoperability

Compatible with CNs from various manufacturers.

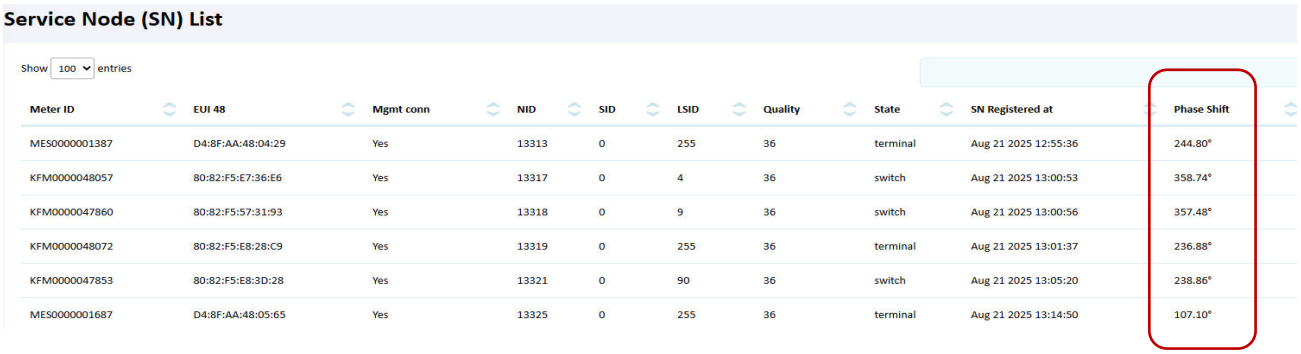
No additional Hardware Required

Only the upgrade of the CNs and the BN is needed.



PRIME Topology

Serial	MAC	Channel	SID	LNID	State	SSID	Phase	Coverage	Conn. Time	Disc. Time	Availability
	40:40:22:37:f2:9c	-	-	-	Base	0					
SAG0227001854	50:0f:59:17:e2:d2	plc1	0	22	Terminal	-	A 358.38º		01-21 18:43	01-22 16:38	99%
SAG0227001936	50:0f:59:17:c7:a4	plc1	0	27	Terminal	-	A 358.02º		01-22 11:29	01-22 16:37	99%
ZIV0037166537	40:40:22:37:1d:c9	plc1	0	42	Terminal	-			01-21 20:43	01-22 16:37	99%
LGZ0022935017	00:0f:93:f9:56:e8	plc1	0	61	Terminal	-	C 125.93º		01-21 20:28	01-22 16:37	98%
LGZ0022935134	00:0f:93:f9:57:5d	plc1	0	75	Switch	128	A 4.50º		01-21 18:50	01-22 16:30	98%
SAG0227002045	50:0f:59:1a:05:1b	plc1	128	18	Terminal	-	A 0.54º		01-21 20:57	01-22 16:35	96%
SAG0237000318	80:82:f5:33:75:ce	plc1	128	109	Terminal	-	A 358.74º		01-22 14:03	01-22 16:35	97%
SAG0227002047	50:0f:59:19:fe:0e	plc1	128	151	Terminal	-	A 358.74º		01-21 20:55	01-22 16:35	97%
LGZ0022935013	00:0f:93:f9:56:e4	plc1	128	231	Terminal	-	A 4.68º		01-21 20:59	01-22 16:35	97%



Service Node (SN) List

Show 100 entries

Meter ID	EUI 48	Mgmt conn	NID	SID	LSID	Quality	State	SN Registered at	Phase Shift
MES0000001387	D4:8F:AA:48:04:29	Yes	13313	0	255	36	terminal	Aug 21 2025 12:55:36	244.80°
KFM0000048057	80:82:F5:E7:36:E6	Yes	13317	0	4	36	switch	Aug 21 2025 13:00:53	358.74°
KFM0000047860	80:82:F5:57:31:93	Yes	13318	0	9	36	switch	Aug 21 2025 13:00:56	357.48°
KFM0000048072	80:82:F5:E8:28:C9	Yes	13319	0	255	36	terminal	Aug 21 2025 13:01:37	236.88°
KFM0000047853	80:82:F5:E8:3D:28	Yes	13321	0	90	36	switch	Aug 21 2025 13:05:20	238.86°
MES0000001687	D4:8F:AA:48:05:65	Yes	13325	0	255	36	terminal	Aug 21 2025 13:14:50	107.10°

KEY SUCCESS FACTORS

- There are already 7 different smart meter providers deploying PRIME 1.4 in Spain.
- Interoperability and interchangeability is the key factor for success.
- The use of OPEN standards are critical to obtain main benefits and spread this solution all over the world.
- Moreover, a new report with phase consumption for three phase smart meters will also help to detect unbalance circuits.