



LMP SH-IP & HRNL-25W EMBER+ / S101 PROTOCOL GUIDE

Public protocol integration guide

DATASHEET

EMBER+

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www.xichtee.com
office@xichtee.com
Company ID: 56695284
Tax ID / VAT: 2122403635



Document control

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Purpose

This guide documents the XICHTEE Ember+ provider: TCP/S101 framing, Glow operations, qualified numeric paths, access and value semantics, interest/notifications, Cluster ownership and a CRC-validated read-only client.

NOTE This is a public guide to the implemented product interface. Browse the live provider and verify the running firmware before relying on version-specific nodes or parameters.



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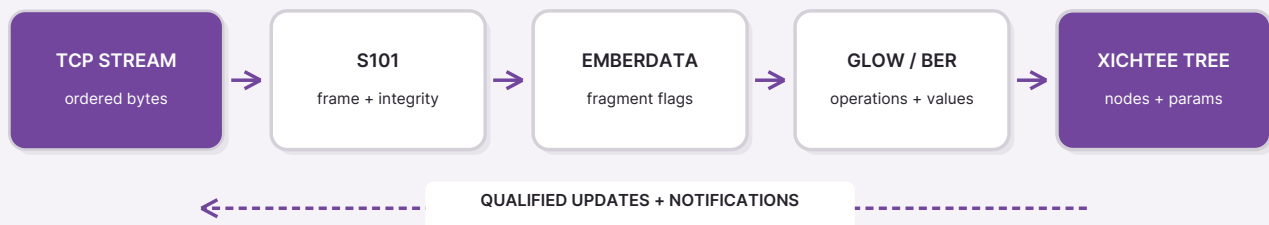
01 • Overview

Provider tree over S101

The device is an Ember+ provider. A consumer opens TCP, frames messages with S101, exchanges EmberData, and browses or changes a hierarchical Glow tree. No automatic greeting or full-tree snapshot is sent when TCP connects.

EMBER+ PROTOCOL STACK

A production consumer should use an Ember+ library and preserve message boundaries above TCP.



GetDirectory starts discovery; SetValue writes; QualifiedParameter data confirms authority.

ITEM	IMPLEMENTED CONTRACT
Role	XICHTEE provider; controller/Viewer is the consumer.
Transport	Plain IPv4 TCP server; stored default port 9000.
Framing	S101 Variant 1 escaped/CRC and Variant 2 length-delimited.
Application	EmberData carrying ASN.1 BER-encoded Glow DTD 2.50.
Elements	Nodes and scalar parameters. No public Matrix, Function or Stream elements.
Values	Integer, Boolean and UTF8String for implemented writes.
Security	No Ember authentication or TLS.

NOTE A successful TCP send is never proof that a SetValue was applied or persisted. Verify the provider's authoritative QualifiedParameter value.



02 · Configure and connect

Enable one or more Ember listeners

In Socket Config, set the Ember+ TCP port and request one or more Ember sockets, save, and perform the requested restart. The licence must permit Ember+ operation. Runtime availability also depends on the shared network-socket budget.

SETTING	VALUE / GUIDANCE
Ember Port	1–65535; stored default 9000.
Ember Sockets	0 disables the server. Up to four concurrent contexts are supported, subject to runtime capacity.
Consumer	Use an Ember+ Viewer or library that supports S101 and Glow.
Connect	Open TCP; expect no greeting. Start with GetDirectory on root/device.
Keepalive	Send S101 keepalive requests during otherwise idle sessions.
Reconnect	Browse again and restore all interest/subscriptions; they are connection-local.

Connection lifecycle

CONSUMER LIFECYCLE

Treat the provider tree as discoverable and versioned rather than hard-coding one startup snapshot.

CONNECT

Open plain TCP to the configured port; no Ember greeting follows.

DISCOVER

GetDirectory root, device and only the branches the application needs.

INTEREST

Directory access or Subscribe establishes connection-local update interest.

RECOVER

On close or authority transition, reconnect, rebrowse and restore interest.

An idle connection may close after about 15 minutes without receive or transmit progress.

IMPORTANT The Ember TCP service is unauthenticated and unencrypted. Restrict it to an isolated trusted control network, VPN or protected tunnel.



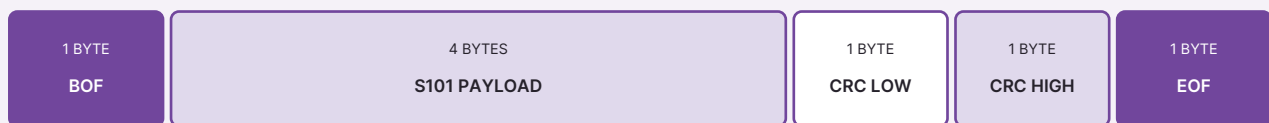
03 · S101 anatomy

Variant 1 · escaped frame with CRC

Variant 1 begins with FE, carries an escaped payload and escaped CRC-16/X-25, and ends with FF. CRC is calculated on the unescaped S101 payload, complemented, and transmitted low byte first.

S101 VARIANT 1 · KEEPALIVE REQUEST

The eight-byte validated frame carries the four-byte payload 00 0E 01 01.

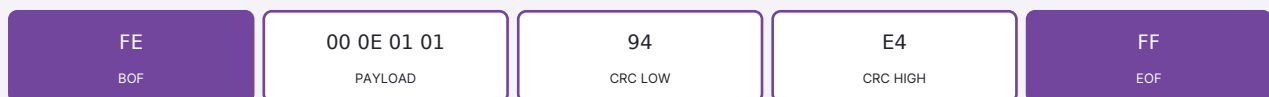


FE begins and FF ends one escaped Variant-1 frame.

Escape FD, and every unescaped byte FD or F8-FF, as FD then byte XOR 20.

CRC-16/X-25: init FFFF, reflected polynomial 8408, final complement, little-endian.

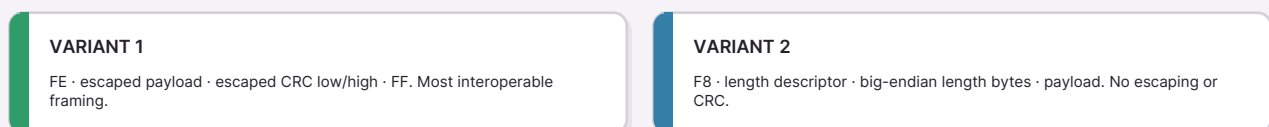
VALIDATED KEEPALIVE REQUEST



All labels and examples are vector text and remain searchable in the PDF.

TWO ACCEPTED S101 VARIANTS

The connection's received variant influences the provider's subsequent replies and updates.



For Variant 2, descriptor bits 0-2 give 0-7 length bytes; upper bits must be zero.

NOTE TCP read boundaries are not S101 frame boundaries. Accept fragmented frames and several complete frames in one read.



04 • EmberData and Glow

Single-packet EmberData header

FIELD	BYTES / VALUE	MEANING
Slot	00	S101 slot 0.
Message type	0E	Ember.
Command	00	EmberData.
Version	01	S101 command version.
Fragment flags	C0	Single packet. 80 first, 00 middle, 40 last.
DTD	01	Glow.
App byte count	02	Two application bytes follow.
App bytes	32 02	Glow DTD 2.50.
Body	variable	ASN.1 BER-encoded Glow tree.

Supported operations

OPERATION	VALUE	IMPLEMENTED BEHAVIOUR
GetDirectory	32 / 0x20	Browse a node or parameter and establish interest.
Subscribe	30 / 0x1E	Track a parameter or selected node; current value is published.
Unsubscribe	31 / 0x1F	Remove connection-local interest; root clears all.
SetValue	Parameter contents	Apply Integer, Boolean or UTF8String where supported.
NULL	Glow NULL	Accepted syntactically but does not change a value.

Directory compatibility

A directory field mask of 0 is the safest general choice. The provider also recognises identifier (1), tree (3) and value (4) requests. Large replies can use First/Middle/Last EmberData fragments; reassemble the logical message before interpreting BER.

IMPORTANT The provider does not supply a dependable formal error result for every unknown path, wrong type, malformed BER or ignored write. Read the qualified value back and keep optimistic UI state provisional.



05 · Browse the tree

Start at Root Device

Numeric identifiers are scoped by their parent. Always retain and send the full qualified path; a bare parameter ID such as 1 is ambiguous.

TOP-LEVEL XICHTEE GLOW TREE

S is the device/licence segment maximum; P is one of ten presets; E is one of ten Custom Effects.

Root

NODE

GetDirectory 0

— 1 · Device

NODE

LMPSH-IP or HRNL-25W

— 90 · Segments

NODE

Segment 1..S

— 20 · Network Config

NODE

IP + socket branches

— 40 · System Status

NODE

telemetry + client counts

— 60 · Presets

NODE

Preset 1..10

— 80 · Custom Effect

NODE

Custom Effect 1..10

— 70 · Rules

NODE

five rules per segment

Root browsing alone does not subscribe the consumer to every periodic System Status value.



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QUALIFIED PATH · SEGMENT 1 RULE 1 ACTIVE

The same path is written with slash or dotted notation: 1/70/1200/710/7000.

NODE 1 DEVICE	NODE 70 RULES	NODE 1200 SEGMENT RULES	NODE 710 RULE 1	PARAM 7000 ACTIVE
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Nodes 1200 and 710 are the Segment 1 and Rule 1 instances.

Parameter 7000 is a read/write Boolean and runtime-only.

GetDirectory on this parameter returns value/attributes and establishes interest.

COPYABLE DOTTED PATH

1 DEVICE	70 RULES	1200 SEGMENT 1	710 RULE 1	7000 ACTIVE
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All labels and examples are vector text and remain searchable in the PDF.



06 • Device, segments and status

Device and segment formulas

PATH / FORMULA	TYPE	MEANING / RANGE
1/8	String RW	Device Name · up to 31 characters.
1/14	Enum RW	Active Mode · 0 means one segment; S-1 means S segments.
1/90/(199+s)	Node	Segment s, where s = 1..S.
Segment RGB	Integer RW	Each component 0-255.
Segment Count	Integer RW	1-120 LEDs.
Segment Name	String RW	Up to 31 characters.

Segments 1-5 parameter IDs

SEGMENT	RED / GREEN / BLUE	COUNT	NAME
1	1 / 2 / 3	7	50
2	11 / 12 / 13	15	51
3	21 / 22 / 23	16	52
4	41 / 42 / 43	17	53
5	61 / 62 / 63	18	54

Segments 6 and above

For segment $s \geq 6$, let $b = 2000 + (s-6) \times 10$. Under node 1/90/(199+s), parameters b+0, b+1 and b+2 are RGB; b+3 is LED Count; b+4 is Name. LMPSH-IP exposes up to two segments; HRNL-25W can expose up to 45 where licensed.

IMPORTANT Use the normal authenticated web interface for network configuration. The Ember transport itself is unauthenticated and unencrypted.



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Public-safe network and status paths

PATH	TYPE	MEANING
1/20/21/22	String R	IP Address.
1/20/21/23	String R	Subnet Mask.
1/20/21/24	String R	Gateway.
1/20/21/36	Boolean R	DHCP Enabled.
1/20/30/31..35	Integer RW	HTTP, Ember, TSL, Pro-Bel and OSC ports · 1–65535.
1/20/30/37	Integer R	Syslog port · 514.
1/20/30/38	Integer R	NTP port · 123.
1/40/4 · /401	Integer R	CPU Core 0 / Core 1 percentage.
1/40/5 · /6	Integer R	RAM / flash usage percentage.
1/40/46	String R	Core temperature.
1/40/461 · /462	String R	Aux sensor 1 / 2.
1/40/463 · /464	Boolean R	GPI 1 / 2.
1/40/56 · /57	Bool / String R	Ethernet link state / speed.
1/40/540	String R	Uptime.
1/40/580 · /581	String R	LED state HEX / RGB text.
1/40/69	Boolean RW	Swap Segments for two-segment operation.

Client-count nodes

PATH	COUNT
1/40/42/1	Ember clients
1/40/43/1	HTTP clients
1/40/84/1	TSL clients
1/40/85/1	Pro-Bel clients
1/40/86/1	Recent OSC senders

NOTE Browse or subscribe to System Status node 40 or the required parameters to receive periodic status changes. A simple root browse is not sufficient.



07 · Presets and Custom Effects

Preset path and parameter formula

For preset $p = 1..10$, the node is $1/60/(99+p)$ and parameter base is $b = 1000 + (p-1) \times 20$.

OFFSET	PARAMETER	TYPE / RANGE
0-2	Red / Green / Blue	Integer RW · 0-255
3	Name	String RW · 31 characters
4 / 7	Start / Stop Effect	Enum RW · numeric values below
5 / 8	Start / Stop Direction	Enum RW · 0 left→right, 1 right→left
6 / 9	Start / Stop Time	Integer RW · 0-10000 ms
10	Constant Mode	Enum RW · 0-19
11	Constant Direction	Enum RW · 0 left, 1 right, 2 centre out
12	Constant Period	Integer RW · 50-10000 ms
13	Fade Out Time	Integer RW · 50-10000 ms
14	Morse Text	String RW · A-Z, 0-9, spaces · 64 chars

Effect values

FIELD	NUMERIC VALUES
Start / Stop	0 Instant, 1 Wipe, 2 Blink, 3 Fade, 4 Breathing, 5 Strobe, 6 Chase, 7 Phone Ring, 10-19 Custom Effects 1-10. Values 8-9 are not used.
Constant	0 Static, 1 Wipe, 2 Blink, 3 Fade, 4 Breathing, 5 Strobe, 6 Chase, 7 Phone Ring, 8 Morse, 9 Audio Monitor, 10-19 Custom Effects.

NOTE Use the numeric values above for Start/Stop Custom Effects; do not infer value numbers only from a consumer's displayed enumeration line order.



Audio Monitor child

Under preset p , the Audio Monitor node is $1/60/(99+p)/(1599+p)$. Let $a = 800 + (p-1) \times 20$.

OFFSET	PARAMETER	TYPE / RANGE
0 / 1	Left / Right Channel	Enum RW · 0–31 represents channel 1–32
2 / 3	Low-Mid / Mid-High Threshold	Integer RW · 0–100; reordered if necessary
4–6	Low Red / Green / Blue	Integer RW · 0–255
7–9	Mid Red / Green / Blue	Integer RW · 0–255
10–12	High Red / Green / Blue	Integer RW · 0–255

Custom Effects

For effect $e = 1..10$, the node is $1/80/(1699+e)$ and base is $c = 14000 + (e-1) \times 10$.

OFFSET	PARAMETER	BEHAVIOUR
0	Custom Effect Name	String RW · 31 characters
1	Live Preview	Boolean RW · only one effect owns preview at a time
2	Timeline Sync	Boolean RW
3	timelineposition	Integer RW · 0–60000 ms
4	Play	Momentary Boolean; write true, authoritative value returns false
5	Pause	Momentary Boolean; write true, authoritative value returns false

NOTE Live Preview, Play, Pause and timeline position are runtime controls. Preview ownership changes can generate updates for both the old and new effect.

08 · Rules and time triggers

Five rules per segment

For segment $s = 1..S$ and rule $r = 1..5$: Segment Rules node = $1199+s$; Rule node = $710 + (s-1) \times 10 + (r-1)$; parameter base $q = 7000 + (s-1) \times 100 + (r-1) \times 10$.

OFFSET	PARAMETER	TYPE / RANGE
0	Active	Boolean RW · runtime-only
1	Preset ID	Enum RW · 0–9
2	TSL Index	Integer RW · effective –1..9999
3	TSL Bit	Integer RW · 0–3
4	OSC Path	String RW · 63 characters
5	OSC Match Mode	Enum RW · Trigger, Exact, Range, String
6 / 7	OSC Value A / B $\times 1000$	Integer RW · –2000000..2000000
8	OSC String	String RW · 31 characters
9	Trigger Source	Enum RW · Disabled, GPI 1/2, Logic 1..10

Active ownership

An Active write is ignored while a maintained GPI/Logic Follow input owns the rule. The provider publishes the current authoritative value so the consumer can correct optimistic state. Rule Active is not persisted and boots inactive.

NOTE The directory may advertise a wider TSL Index maximum, but the effective accepted range is –1..9999. Integrations should use this narrower contract.



Time Trigger compatibility subset

A rule's Time Trigger node is $1800 + (s-1) \times 10 + (r-1)$, below the qualified Rule path. The parameter base is $12000 + (s-1) \times 100 + (r-1) \times 20$.

SLOT	UNIQUE PUBLICLY SAFE OFFSETS	FIELDS
1	0–13	Mode, Action, Hour, Minute, Day, Month, Year, Monday–Sunday
2	14–19	Mode, Action, Hour, Minute, Day, Month

Time values

FIELD	VALUE
Mode	0 Disabled, 1 Once, 2 Daily, 3 Weekly
Action	0 Set FALSE, 1 Set TRUE
Hour / Minute	0–23 / 0–59
Day / Month / Year	0 clears the date; otherwise a valid date with year 1970–9999
Weekdays	Boolean Monday through Sunday on Slot 1

IMPORTANT Do not address Slot 2 Year or weekday fields in this firmware baseline: those advertised IDs are not independent. Configure the complete second slot through the authenticated web UI until a later protocol baseline states otherwise.

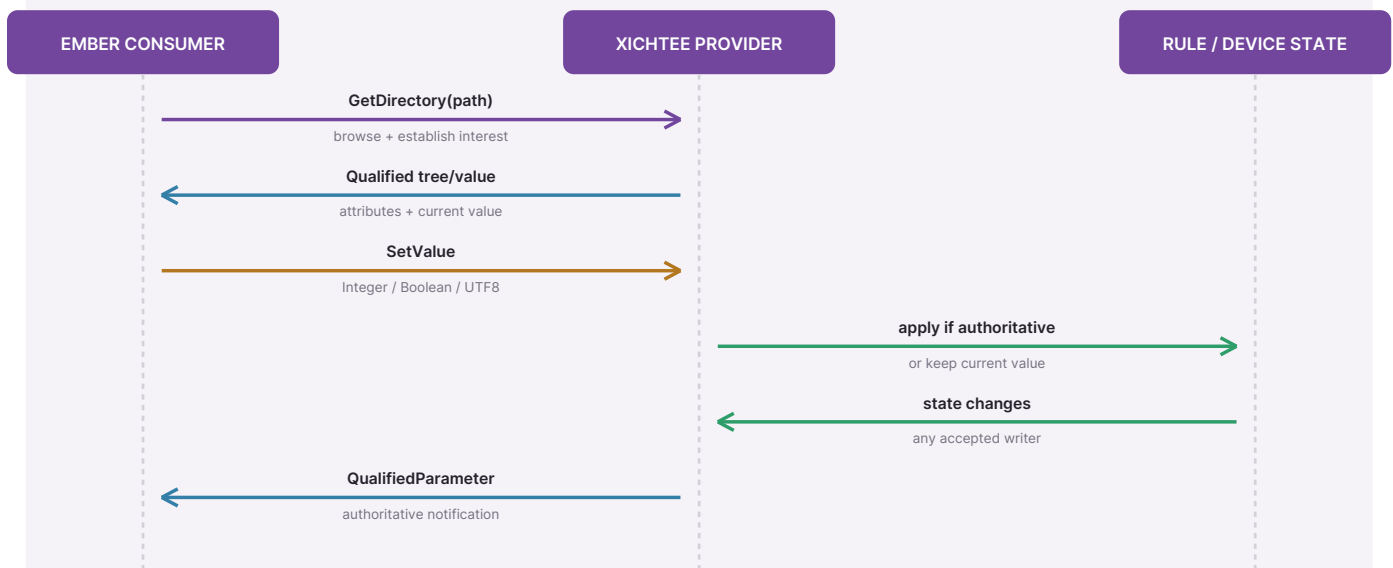
09 • Interest and notifications

Directory access can establish interest

A successful GetDirectory on a parameter establishes interest in that parameter. A successful GetDirectory on a node establishes interest in parameters below that ancestor. Ordinary Rule Active changes therefore do not require a numeric StreamIdentifier.

BROWSE, WRITE AND OBSERVE

Interest and explicit subscriptions live only for the current TCP connection.



Verify the echoed value; keep optimistic local state provisional until it agrees.

INTEREST SOURCE	BEHAVIOUR
GetDirectory parameter	Later changes for that parameter are published.
GetDirectory ancestor node	Later changes below that ancestor are published.
Subscribe parameter	Current value is published immediately, then later changes.
Subscribe selected node	Current contained values and later changes are published.
Unsubscribe node	Removes parameter subscriptions below it; root clears all interest.
Reconnect	All directory interest and subscriptions must be rebuilt.

NOTE Rule Active notifications can originate from Ember+, web, OSC, Pro-Bel, GPI/Logic, NTP or accepted Cluster live state. Unchanged values do not generate a change notification.



10 · Working read-only client

Get Segment 1 / Rule 1 / Active

This byte-exact, non-mutating Variant-1 GetDirectory request targets 1.70.1200.710.7000. It returns the current Boolean and establishes interest. The example validates S101 CRC but intentionally leaves BER/Glow decoding to a production Ember+ library.

```
import socket

DEVICE, PORT = "192.0.2.10", 9000 # documentation-only address
REQUEST = bytes.fromhex("""
FE 00 0E 00 01 C0 01 02 32 02
60 24 6B 22 A0 20 69 1E A0 0A 0D 08
01 46 89 30 85 46 B6 58
A2 10 64 0E A0 0C 62 0A
A0 03 02 01 20 A1 03 02 01 00
A7 A8 FF
""")

def crc_x25(data):
    crc = 0xFFFF
    for byte in data:
        crc ^= byte
    for _ in range(8):
        crc = ((crc >> 1) ^ 0x8408) if crc & 1 else crc >> 1
    crc ^= 0xFFFF
    return (~crc) & 0xFFFF

def receive_v1(peer):
    raw = bytearray()
    while not raw or raw[-1] != 0xFF:
        part = peer.recv(1)
        if not part: raise ConnectionError("closed before EOF")
        raw += part
    if raw[0] != 0xFE: raise ValueError("unexpected S101 BOF")
    decoded, escaped = bytearray(), False
    for byte in raw[1:-1]:
        if escaped: decoded.append(byte ^ 0x20); escaped = False
        elif byte == 0xFD: escaped = True
        else: decoded.append(byte)
    payload = decoded[:-2]
    received = int.from_bytes(decoded[-2:], "little")
    if crc_x25(payload) != received: raise ValueError("bad CRC")
    return bytes(payload)
```

NOTE The request is 51 bytes and its CRC bytes are A7 A8. Replace the documentation-only address with the device or current Cluster member being read.



Connect and read one CRC-valid response

```
assert len(REQUEST) == 51
assert crc_x25(REQUEST[1:-3]) == int.from_bytes(REQUEST[-3:-1], "little")

with socket.create_connection((DEVICE, PORT), timeout=3) as peer:
    peer.sendall(REQUEST)
    response = receive_v1(peer)
    print(f"CRC-valid EmberData response: {len(response)} bytes")
```

Production client requirements

REQUIREMENT	GUIDANCE
S101 stream decoder	Handle TCP fragmentation, multiple frames, escaping/CRC and Variant 2.
EmberData fragments	Reassemble First/Middle/Last packets before decoding the logical Glow body.
BER / Glow	Use the official SDK or a maintained compatible library; do not parse values by byte offsets.
Discovery	Browse live nodes and fields; tolerate additive parameters and absent licence-dependent branches.
Writes	Set one clear value, then wait for authoritative QualifiedParameter confirmation.
Keepalive	Send S101 keepalive requests during idle periods and reconnect with backoff.
Reconnect	Rebrowse and restore all directory interest/subscriptions.

Validated keepalive

MESSAGE	S101 VARIANT-1 WIRE HEX
Request	FE 00 0E 01 01 94 E4 FF
Response	FE 00 0E 02 01 FD DC CE FF

NOTE For production browsing and writes, prefer the official Ember+ Viewer or client libraries rather than embedding captured BER messages.



11 • Cluster and persistence

Read access and write authority are separate

CLUSTER EMBER+ BEHAVIOUR

Every SetValue still passes the central Cluster ownership decision.

STANDALONE / OFF

Browse, subscribe and write according to parameter access.

PRIMARY MASTER

Browse, subscribe and write on the active master.

FOLLOWER

Browse/read/subscribe remain available; all SetValue operations are ignored.

BACKUP STANDBY

Browse/read/subscribe remain available; SetValue is ignored.

BACKUP LEADER

Writes are accepted only while the ready elected backup owns control.

AUTHORITY CHANGE

Backup Ember connections close on promotion and return to standby; reconnect.

Followers and standby Backup members can still publish followed Rule Active notifications.

STATE CLASS	PERSISTENCE / CONFIRMATION
Rule Active	Runtime-only; boots inactive.
Custom preview/play/pause	Runtime controls; momentary Play/Pause return false.
Configuration SetValue	RAM changes save after about 120 seconds of quiet time.
Qualified echo	Confirms current authoritative RAM value, not durable flash completion.
Ignored Cluster write	Best-effort authoritative value publication corrects optimistic state.
Power cycle	Do not power-cycle immediately after a configuration write awaiting autosave.

IMPORTANT Reconnect and rediscover after either Backup authority transition. This intentionally prevents a partial S101 write from crossing the ownership boundary.



12 · Operations and reference

Troubleshooting

SYMPTOM	CHECK
TCP refused	Licence, port, non-zero Ember sockets, applied restart, socket budget, network path and Cluster transition.
Connected but no data	The provider sends no greeting; issue GetDirectory.
No update after browse	Browse the actual parameter or an ancestor; root browse alone does not imply all periodic status traffic.
Write appears ignored	Qualified path, value type/range, maintained input ownership and Cluster authority.
Optimistic UI differs	Replace local value with the authoritative QualifiedParameter response.
Connection closes	Reconnect with backoff; rebrowse and restore all interest/subscriptions.
CRC failure	Decode escaping first, then calculate X-25 over payload and compare little-endian CRC.
Large directory incomplete	Reassemble EmberData First/Middle/Last fragments before BER decoding.

Quick reference

TOPIC	VALUE
Role	XICHTEE Ember+ provider
TCP port	Stored default 9000; zero Ember sockets disables service
Framing	S101 Variant 1 escaped + CRC, or Variant 2 length-delimited
Glow DTD	2.50
Operations	GetDirectory, Subscribe, Unsubscribe, SetValue
Writable scalar types	Integer, Boolean, UTF8String
Readback	Qualified tree/parameter data; verify authoritative value
Idle policy	Connection may close after about 15 minutes without progress



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Official references

Official Ember+ SDK repository

<https://github.com/Lawo/ember-plus>

Official Ember+ protocol document

<https://github.com/Lawo/ember-plus/blob/master/documentation/Ember%2B%20Documentation.pdf>

Official Ember+ Viewer releases

<https://github.com/Lawo/ember-plus/releases>

Compatibility

This guide applies to LMP5H-IP and HRNL-25W firmware v1.1.193 (build 193). It documents the public-safe implemented tree, product-specific access/ranges, notification rules, persistence and Cluster behavior in addition to Ember+/S101 framing.

IMPORTANT The provider is unauthenticated and unencrypted. Any reachable consumer can attempt writes to exposed read/write parameters; network isolation is part of the integration contract.