TIMEOUTS
Best Practices

CHARGE X consortium

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1 Introduction

This study investigates common timeouts encountered in the electric vehicle (EV) charging communications process. Many different timeouts are defined within the EV charging communications protocols. These timeouts can either be a fixed value or a defined range of values. In both cases, the timeout defines the duration of time for which one or both parties in the communications session are expected to wait for some action or process to complete before terminating the charge attempt. These timeout-based terminations are intended to prevent the charging process from becoming stuck indefinitely in any particular step. These terminations also enable a retry of the terminated charging session to begin. However, misaligned timeout values can have a significant negative impact on the user experience. Premature termination of charging sessions due to inappropriate timeout settings can lead to charging failures, causing inconvenience, wasted time, and frustration for users. These disruptions can degrade the overall user experience, making it essential to carefully manage and align timeout values with the relevant actions and processes to ensure reliable and satisfactory EV charging sessions.

The core objective of this study is to boost reliability and enhance user experience by conducting a thorough review of timeout-based issues in EV charging and delivering a set of recommendations to modify these existing timeouts. These recommendations are informed by feedback gathered from multiple EV charging partners. This document is intended to inform electric vehicle supply equipment (EVSE) and EV manufacturers, EV charging infrastructure developers, and policymakers responsible for designing and implementing EV charging protocols and systems.

1.1 Motivation

The motivation to make recommendations to existing timeouts arises from the need for more reliable and user-friendly EV charging solutions given rising EV adoption. For direct-current fast charging, which requires a more complex coordination between vehicle and charger, it is more common for charging sessions to encounter standard timeouts, often due to misalignment between the prescribed timeout values and real-world process durations. Based on customer feedback, this misalignment is most likely to cause premature charging failures.[1] To overcome such premature failures, EV and EVSE manufacturers frequently adjust these timeouts beyond specified ranges, further complicating an already intricate EV charging ecosystem. This document addresses these challenges by thoroughly examining the most frequently encountered timeouts based on feedback from EV charging partners and analyzing their root causes across common EV-EVSE communication standards. Our objective is to thereby enhance the charging success rate without compromising the overall user experience and to reduce the interoperability challenges posed by custom, wide-ranging timeout values being implemented across the EV charging ecosystem.

[1] Jeff St. John. 2023. "EV chargers have a big reliability problem. Can the government fix it?" *Canary Media*, Dec. 11, 2023. www.canarymedia.com/articles/ev-charging/ev-chargers-have-a-big-reliability-problem-can-the-government-fix-it.

1.2 Scope

This work focuses exclusively on the timeouts outlined in commonly used EV-EVSE communication standards such as ISO 15118[2] and DIN SPEC 70121.[3] The focus of this document is direct-current charging, but some content may also be applicable to alternating-current charging as defined in ISO 15118.

2 Timeouts Recommendations

2.1 Overview

Table 1 and Table 2 provide recommendations for modifying timeout values in two EV charging communications standards, DIN 70121 and ISO 15118, respectively. The column titled "Relevance" categorizes each timeout based on the recommended action described in more detail below. Also, additional discussion is provided below the tables for a subset of the line items.

Recommended action based on relevance:

- **Interoperability with legacy equipment:** These timeouts primarily cause issues only with legacy equipment. There is no fundamental mismatch between the real-world process duration and the existing timeout value. New equipment, for the most part, does not have any issues meeting these timeout constraints. Therefore, it is not recommended that these timeout values be modified in their respective standards. However, modified timeout values are provided, and utilizing these timeout values can increase the likelihood of achieving a successful charging session with legacy equipment. One way in which manufacturers might make use of these extended timeout values would be to continue operating according to the standard values for an initial charging attempt and then, if the first charge attempt fails, extending the timeout value to the recommended duration from this document for subsequent charge attempts.
- **Performance improvement:** These timeouts are deemed to be longer in duration than necessary. For these timeouts, once the recommended value is reached, it is seldom seen that the relevant process reaches a successful conclusion within the remaining duration, as specified by the existing timeout value. In these cases, if an automatic retry option is available, then a successful charging session can be established more quickly by terminating early and initiating the retry, rather than waiting the additional time. For these timeouts, it is recommended that manufacturers target the lower minimum value listed and that these lower bounds for the timeout range be considered for inclusion into the associated standard.
- **Ongoing issue:** These timeouts are causing ongoing issues with fielded equipment and are characterized by a fundamental mismatch between the currently chosen timeout value and the real-world process duration. For these timeouts, it is recommended the values proposed here be considered for inclusion into the associated standard.

[2] International Organization for Standardization. 2019. *Road vehicles — Vehicle to grid communication interface. Part 1: General information and use-case definition*. Geneva, Switzerland. ISO 15118. www.iso.org/standard/69113.html.

[3] European Standards. 2014. *Electromobility - Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging System*. DIN SPEC 70121. www.en-standard.eu/din-spec-70121-electromobility-digital-communication-between-a-d-c-ev-charging-station-and-an-electric-vehicle-for-control-of-d-c-charging-in-the-combined-charging-system-text-in-english/.

2.2 Tables

Table 1. DIN 70121

Table Name	Timer/Timeout Name	Existing (Min./Typical/Max.)	Recommended (Min./Typical/Max.)	Unit	Relevance	Rationale
Table 8	TT_EVSE_SLAC_init	20/–/–	10/–/20	s	Performance improvement	Matching processing is likely to fail if it has not matched after 10 s
Table 77	V2G_EVCC_CableCheck_Timeout	–/–/40	–/–/60	s	Interoperability with legacy equipment	Allow extra time for legacy equipment to perform cable checks
Table 77	V2G_EVCC_PreCharge_Timeout	–/–/7	–/–/20	s	Interoperability with legacy equipment	Allow extra time for legacy equipment to perform pre-charge

Table 2. ISO 15118

Table Name	Timer/Timeout Name	Existing (Min./Typical/Max.)	Recommended (Min./Typical/Max.)	Unit	Relevance	Rationale
Table A.1	TT_EVSE_SLAC_init	20/–/50	10/–/20	s	Performance improvement	Matching processing is likely to fail if it has not matched after 10 s [a]
Table 111	V2G_EVCC_CableCheck_Timeout	–/–/40	–/–/60	s	Interoperability with legacy equipment	Allow time for legacy equipment to perform cable checks [b]
Table 111	V2G_EVCC_PreCharge_Timeout	–/–/7	–/–/20	s	Interoperability with legacy equipment	Allow time for legacy equipment to perform pre-charge [c]
Table 109	V2G_EVCC_Ongoing_Timeout	–/–/60	–/–/140	s	Ongoing issue	User authorization typically takes longer than 60 s [d]

[a] Per ISO 15118-3, the TT_EVSE_SLAC_init timeout can be configured as a minimum of 20 s and a maximum of 50 s in Table A.1. This is defined as the time between detecting State B and receiving CM_SLAC_PARM.REQ on the EVSE side. Therefore, if an EVSE does not receive a CM_SLAC_PARM.REQ, the requirement [V2G3 M06-07] applies. The beginning of this timer is defined in [V2G3-A09-12]. However, it is required by the EV to send a CM_SLAC_PARM.REQ per [V2G3-A09-05], which is defined as a maximum of 10 s in Table A.1. Therefore, there is an apparent buffer of 10 s. To reduce the time to charge and enhance user experience, it is recommended that this process fail as quickly as possible by modifying the minimum and maximum values for the TT_EVSE_SLAC_init timeout as given in Table 2.

[b] During the cable check phase, the EVSE is required to perform a number of checks. These are outlined in [IEC 61851-23 CC.4.1.2]. Here, the first requirement is to perform a functional check of the isolation monitoring device under a controlled maximum rated voltage communicated in ChargeParameterDiscovery. Now, in the case that an EV with maximum 400-V rechargeable energy storage system voltage was connected and then an EV with maximum 800-V rechargeable energy storage system voltage shows up in a new session, the EVSE typically needs some time to reallocate its power modules. However, the EVSE and EV communicate about their charging parameters, including maximum voltages, only during the ChargeParameterDiscovery phase. Therefore, in this scenario, it is likely that this reallocation may not happen quickly enough, and the V2G_EVCC_CableCheck_Timer hits the 40-s V2G_EVCC_CableCheck_Timeout [V2G2-702, Table 111]. To allow more time for EVSE and some legacy equipment to perform cable checks, we recommend extending this specific timeout to 60 s as mentioned in Table 2. Additionally, we also recommend that the EV check for EVSE port voltage in the first couple seconds and fail early if no EVSE port voltage is observed during the ramp-up.

[c] Based on input from charging station operators and EVSE and EV manufacturers, it is observed that legacy EVSE often needs more time to ramp up its output voltage to the maximum target voltage agreed upon in ChargeParameterDiscovery. Therefore, in this scenario, it is likely that the V2G_EVCC_ PreCharge _Timer hits the 7-s V2G_EVCC_PreCharge_Timeout [V2G2-706, Table 111]. To allow more time for EVSE and some legacy equipment to perform pre-charge voltage ramp-up, we recommend extending this specific timeout to 20 s as mentioned in Table 2. Note that this follows the 20-s timeout requirements specified in IEC 61851-23 Section CC.5.1.

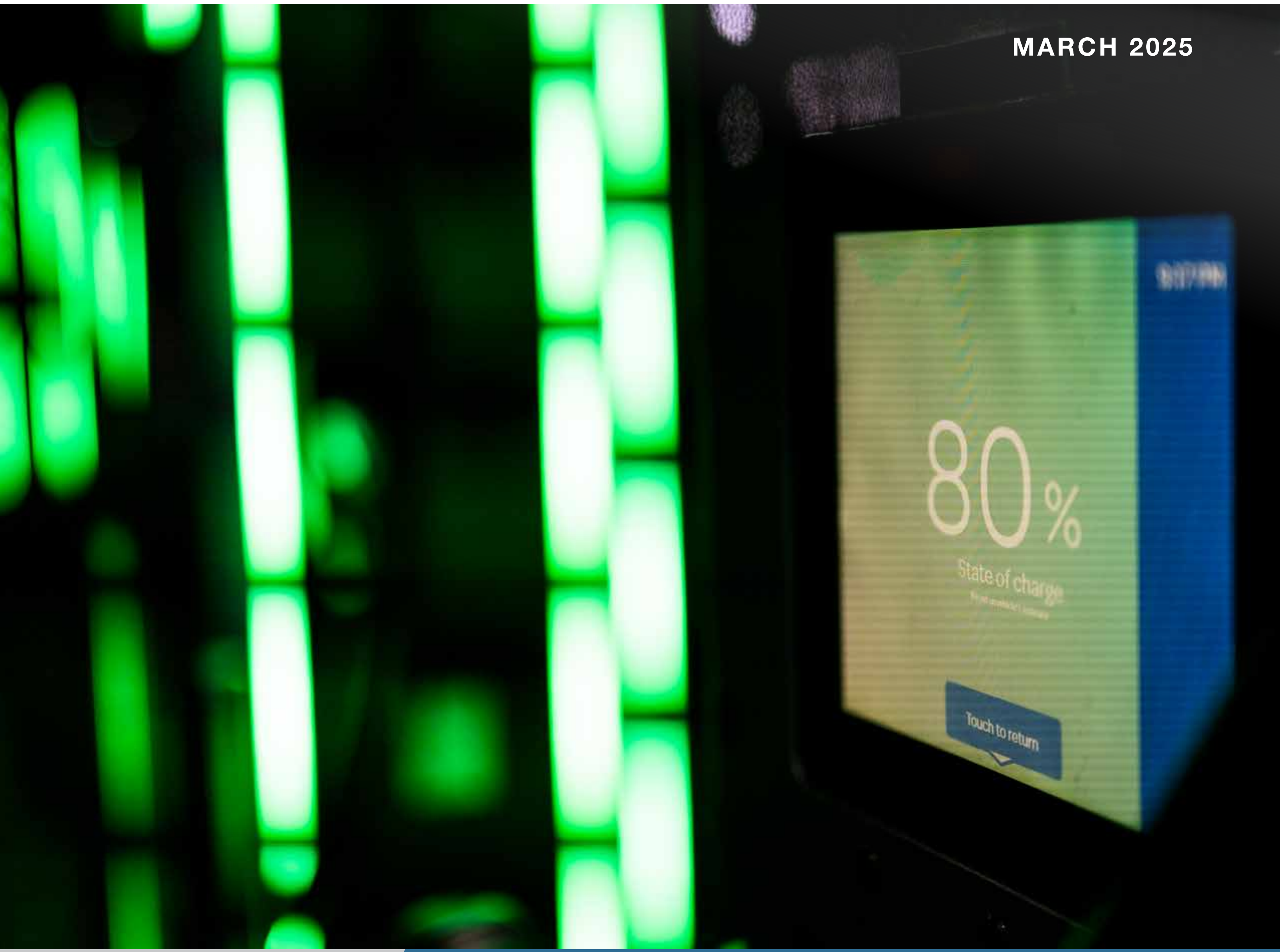
[d] Based on input from charging station operators and EVSE and EV manufacturers, it is highlighted that the frequent failures are observed during the authorization phase. Per ISO 15118-2 Table 111, the V2G_EVCC_Msg_Timeout is set to 2 s during authorization, and this timer (and hence the timeout) is satisfied if the EV communication controller receives a valid AuthorizationRes. Now, to allow more time for the EVSE to process payment information, the EVSEProcessing parameter in AuthorizationRes can be set to "Ongoing." This allows the EVSE to satisfy the V2G_EVCC_Msg_Timeout while holding the authorization loop for another 60 s (Table 109). However, based on input from charging station operators and EVSE and EV original equipment manufacturers, 60 s is deemed too short, and customers frequently need more than 140 s to present valid payment information. Therefore, we recommend extending the V2G_EVCC_Ongoing_Timeout to 140 s. [V2G2-711] shall apply if V2G_EVCC_Ongoing_Timer is equal to or larger than 140 s and no parameter EVSEProcessing equal to "Finished" has been received in AuthorizationRes. This longer timeout is aligned with proposals made for ISO 15118-2 Edition 2. Note that EVSEProcessing equal to "Ongoing" can also be sent in two other phases: (1) ChargeParameterDiscovery and (2) CableCheck. Despite this, it is considered a reasonable trade-off due to the complexity of adding more timers and timeouts specific to authorization. Additionally, the V2G_EVCC_CableCheck_Timeout is independent of this process and times out at 60 seconds per Table 2 as specified in [V2G2-702].

3 Conclusion

The objective of this document is to provide guidance on best practices to avoid timeout-related issues, which can negatively impact charging interoperability and first-time charging success. Based on industry input, a set of timers from the relevant standards and communications protocols were selected for this document. The issues and best practices for these timer values were analyzed, and new values were compared against their prescribed values. Rationale was provided on changes to these values. This document also distinguishes its guidance based on the vintage of equipment that the proposed changes are most relevant for, identifying when a change will improve interoperability primarily with legacy equipment and when a change is relevant for equipment still being deployed today. By employing the modified timeout values in this document, manufacturers can improve their charging success rate, reduce the time to initiate a charging session, and improve the charging experience for EV drivers.

About the ChargeX Consortium

The National Charging Experience Consortium (ChargeX Consortium) is a collaborative effort between Argonne National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, electric vehicle charging industry experts, consumer advocates, and other stakeholders. Funded by the Joint Office of Energy and Transportation, the ChargeX Consortium's mission is to work together to measure and significantly improve public charging reliability and usability by June 2025. For more information, visit chargex.inl.gov.



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