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ORCA

Industrial GPS Asset Tracker

Activation & Configuration Guide

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Thank-you for choosing the TEKTELIC ORCA for your GPS Asset Tracking Solution. This document provides the best practices for activating and configuring the ORCAs.

Note: This guide is relevant for ORCAs with NA region FW only.
The ORCAs are shipped in a state of deep sleep to save battery life. They are activated through the use of an included magnet.

As a LoRaWAN Class A device, the ORCA sends uplink transmissions at various *data rates* (DR). In the NA region, the lowest data rate, DR0, has a maximum payload size of 11 bytes. This limitation may be problematic for reported device telemetry that is larger in data size, such as GPS coordinate and UTC information.
This guide outlines the best practices for activating and configuring the ORCA so as to avoid the limitations introduced by the DR. Once configured correctly, the devices will operate normally for the remainder of the current network join session.

Follow this manual to ensure that the activation process of your ORCAs goes smoothly.

ADR ..... Adaptive Data Rate
CRC ..... Cyclic Redundancy Check
DL ..... DownLink
DR ..... Data Rate
FW ..... FirmWare
GPS ..... Global Positioning System
GW ..... GateWay
LED ..... Light-Emitting Diode
LoRa ..... Long-Range
LoRaMAC ..... LoRaWAN MAC
LoRaWAN ..... LoRa Wide Area Network
MAC ..... Medium Access Control
MQTT ..... Message Queueing Telemetry Transport
NA ..... North America
NS ..... Network Server
PSR ..... Packet Success Rate
RSSI ..... Received Signal Strength Indicator
Rx ..... Receive / Receiver
SF ..... Spreading Factor
SNR ..... Signal-to-Noise Ratio
TRM ..... Technical Reference Manual
Tx ..... Transmit / Transmitter
UL ..... UpLink
UTC ..... Universal Coordinated Time
v ..... version
ver. ..... version

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Background on LoRaWAN DR & ADR

The ORCA is programmed in accordance with the LoRaWAN Specification 1.0.2 for Class A devices as published by the LoRa Alliance [1].

The following are relevant facts about LoRaWAN class A device operation:

- Messages can be sent from the device to the NS (uplinks) or from the NS to the device (downlinks). Both directions go through the GW(s).
- Each UL or DL transmission has certain defining parameters. LoRaWAN uses an abstraction on top of those parameters called *data rate*. The DR is an integer value between 0 and 15 and influences the signal modulation, spreading factor, and bandwidth.
- ULs in the North America region can be sent using DR0 – DR4. A lower DR means a larger spreading factor and longer time-on-air for each message. A lower DR also produces signals most robust to interference, and thus is recommended for communication at longer possible ranges.
- *Adaptive Data Rate* (ADR) is a LoRaWAN mechanism which allows the device and/or NS to dynamically change the DR and Tx power of the device in order to optimize power consumption. For example, if many consecutive ULs are received with good SNR and RSSI, the NS may send a DL message to the device to tell it to lower its Tx power and increase its DR.
- These DL messages are in the form of a LoRaMAC command called a *LinkADRReq*. *LinkADRReq* commands can tell the device to:
    - Change the Tx power level.
    - Change the DR.
    - Set the *NbTrans* value.
    - Change which channels over which messages can be sent via a *channel mask* setting.
- The channel mask is a device setting which is crucial for good Packet Success Rates (PSR). In the NA region, LoRaWAN end devices operate by default over all 64 channels, but some GWs operate at fewer than 64. The channel mask in effect is a way to choose a network deployment such that it covers less than the full 64 channels.
- In the NA region for LoRaWAN Specification 1.0.2, the channel mask is sent as a *LinkADRReq* command in DL0 (the first DL after the JOIN ACCEPT). If this DL is not received by the device, the channel mask will not be set, and the device will send messages on all 64 channels instead of only the ones that the GW is listening to. This may lead to up to 88% packet loss in the case of 8-channel GWs.
- If the device joins the network and has ADR disabled in its configuration settings, the channel mask in DL0 will be ignored (nacked) and not applied, also potentially leading to packet loss.

Recommended Configuration

ULs at DR0 (SF10 and 125 kHz bandwidth for the NA LoRaWAN region), have a maximum payload size of 11 bytes. Some reported device telemetry may be greater than 11 bytes in length. For example, the ORCA's default configuration is to report GPS coordinates and UTC data every hour, which have a total payload length of 20 bytes.

Furthermore, mobile devices such as the ORCA may be deployed in a use-case where they can physically move around faster than the ADR algorithm can adjust the DR and Tx power. In these types of mobile use-cases, it is recommended that ADR is disabled.

Because of these limitations, it is recommended that ADR and DR0 operation be avoided in order to optimize data transmission. The best configuration for mobile ORCA devices to maximize LoRaWAN coverage while avoiding issues at DR0 is to operate at DR1 and disable ADR. The following section describes the procedure for configuring the ORCAs to ensure they operate as expected.

Activation & Configuration Procedure

The steps below detail the procedure for activating and configuring new ORCA ORCAs. The high-level procedure for activating ORCAs is shown in Figure 1.

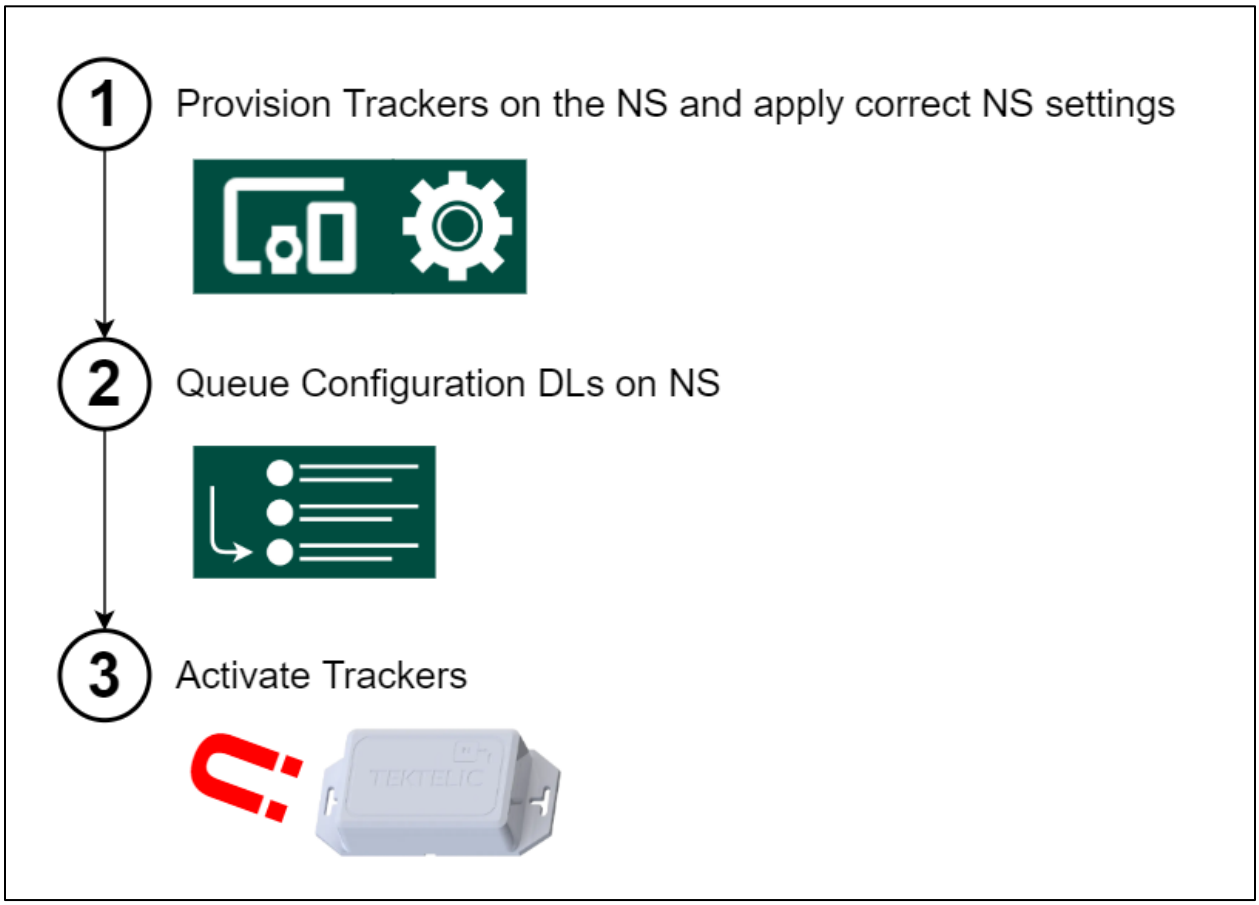

Figure 1: High-Level Activation & Configuration Procedure

1. Using the commissioning keys provided with the ORCAs, add and provision the new ORCAs on the Network Server as shown in Figure 2 to allow them to join.

   NOTE: The next step is applying the proper *Advanced Network Settings*. This can be done either on a device-to-device basis when adding each new device, or globally applied to all devices in a single NS application. If using the latter method, the *Use application settings* checkbox must be checked when adding each new device, as shown in Figure 2.

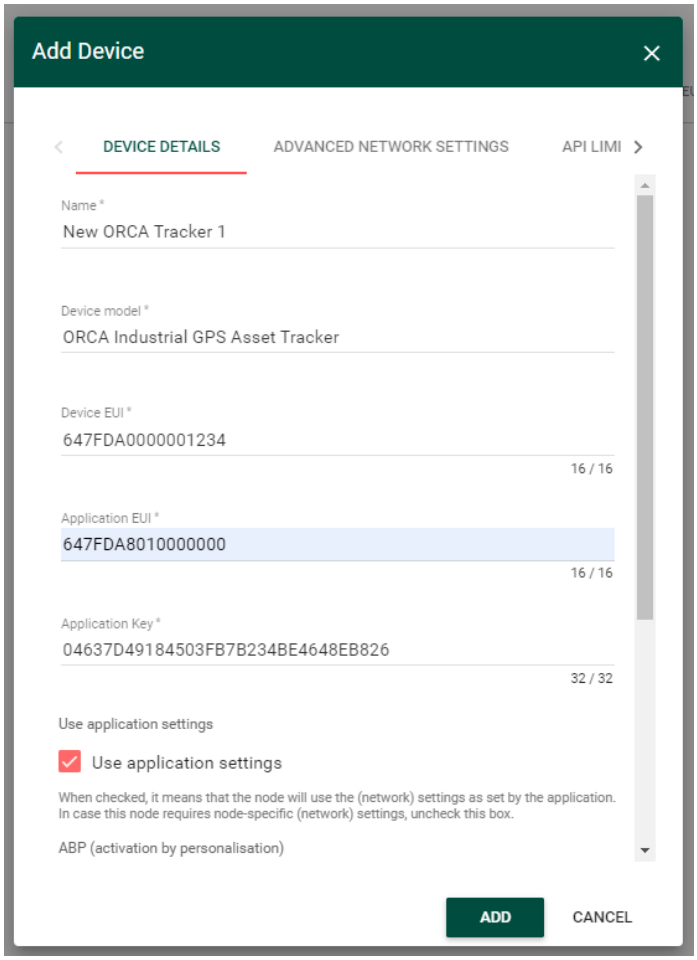

Figure 2: Provisioning a New ORCA on the NS

2. Once all the new ORCAs have been provisioned on the NS, go to the *Advanced Network Settings* tab for the NS application in which the ORCAs are provisioned. Ensure the following settings are configured (as shown in Figure 3):
    a. Ensure the *Enable ADR* checkbox is checked.
    b. In the *ADR Advanced Settings*, Select **DR1** for the min and max data rates, and select **0 (Max Power)** for the min and max Tx power.

        NOTE: DR1 and Tx Power 0 provide the maximum transmission range for the ORCAs. Any other settings besides DR0 may also be selected depending on power consumption constraints.
    c. Ensure the proper default channel mask for your GW(s) is selected. For example, TEKTELIC KONA Micro GWs use 8 channels, so the 8-channel default mask must be selected if using Micro GWs.

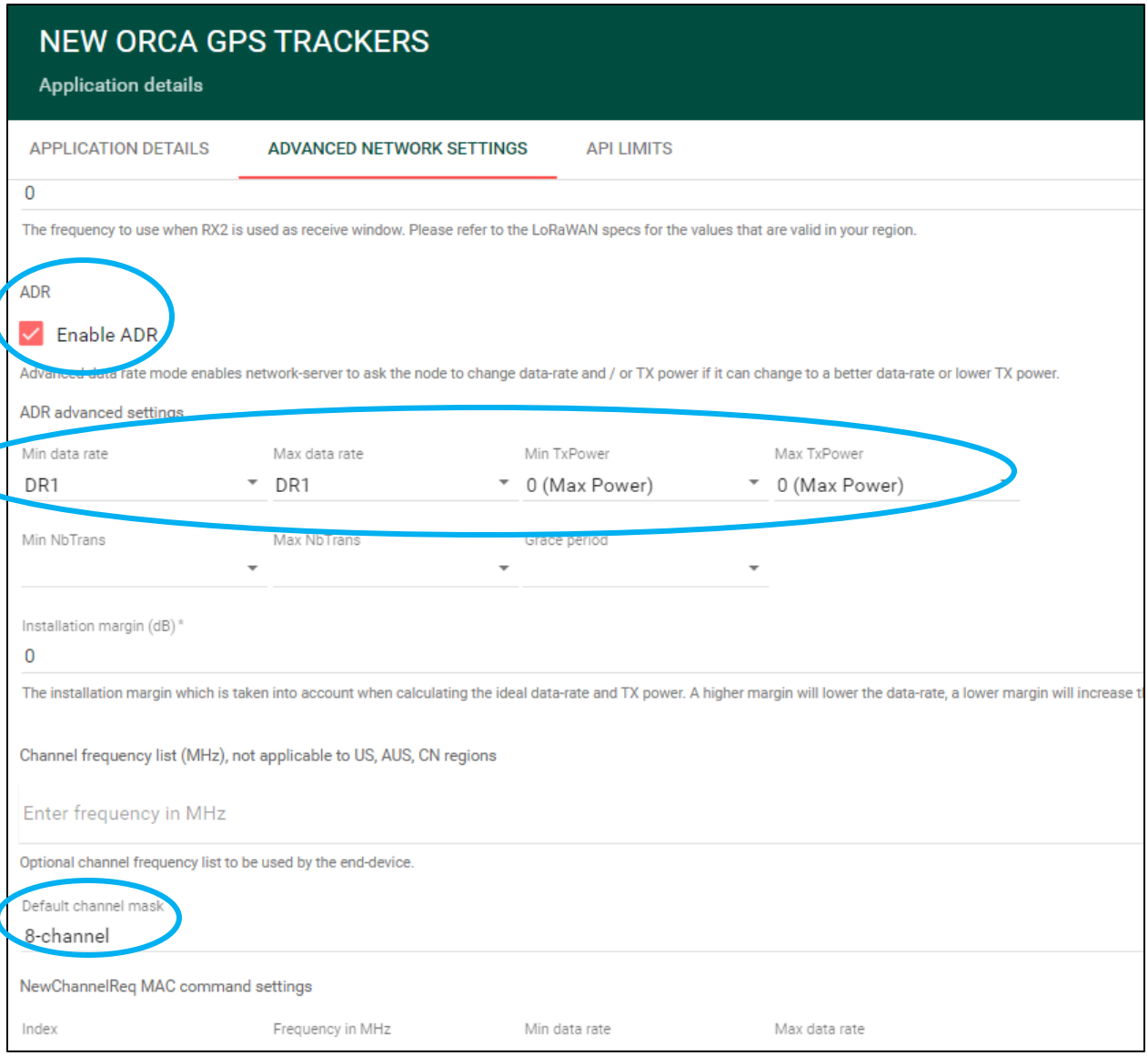

Figure 3: Advanced Network Settings

3. Using your preferred method of forming and sending DL messages (Sensor Config App, MQTT through the command line, etc.), queue the following 3 DLs in this order. Each DL should be sent on ***LoRaWAN port 100***.
    a. Set the default LoRaMAC Tx Power number to 0 (max power) and the default DR number to DR1.

        Base64: **kgEA**

        Hexadecimal: **92 01 00**

    b. Change any other desired application settings away from default and save both LoRaMAC and Application settings. The following example command changes the reporting period of GPS data to 3 minutes.

        Base64: **oAAAADyiAAOjAAPwYAA=**

        Hexadecimal: **A0 00 00 00 3C A2 00 03 A3 00 03 F0 60 00**

c. Disable the ADR and do not save the configuration settings.

Base64: **kQAC**

Hexadecimal: **91 00 02**

After the DLs have been formatted and sent, you should be able to see them in the *Downlink Queue* tab for each ORCA in the NS as shown in Figure 4.

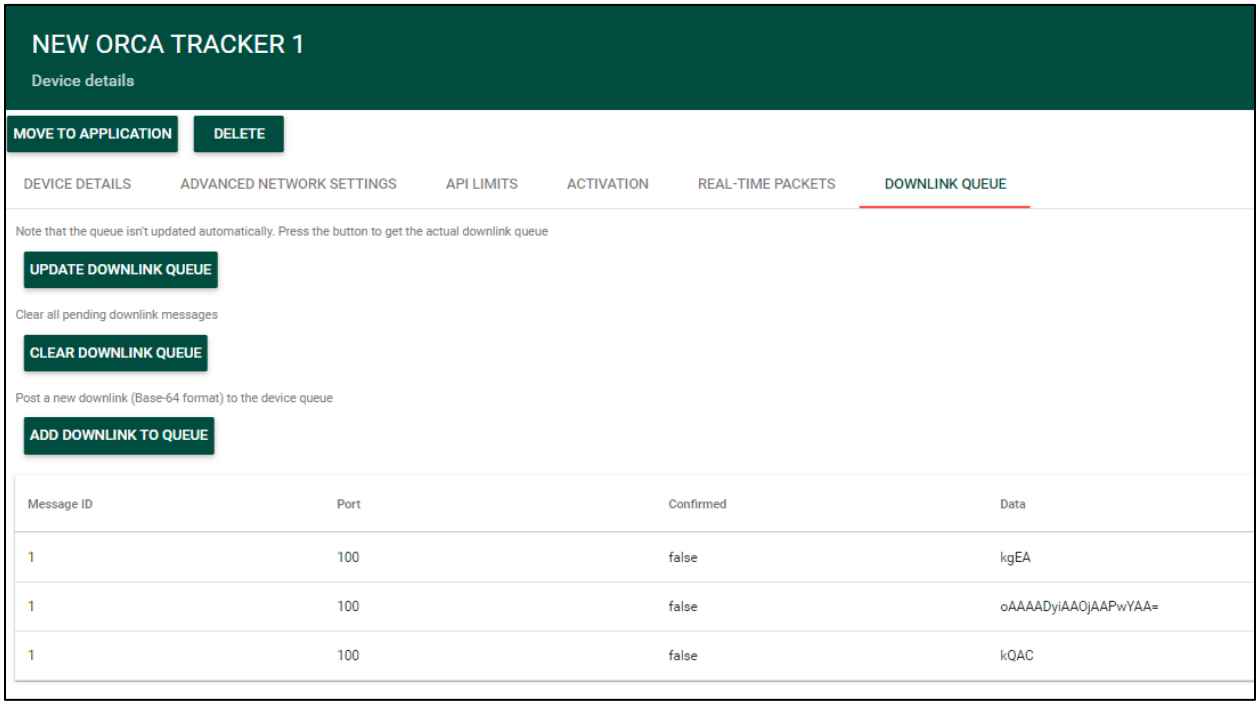

Figure 4: Queued Configuration DLs

4. Ensure the ORCAs are within range of the GW and ensure that the GW is online.
5. In the Network Server, navigate to the *Real-Time Packets* tab of the newly-added ORCA which you are about to activate, as shown in Figure 5.

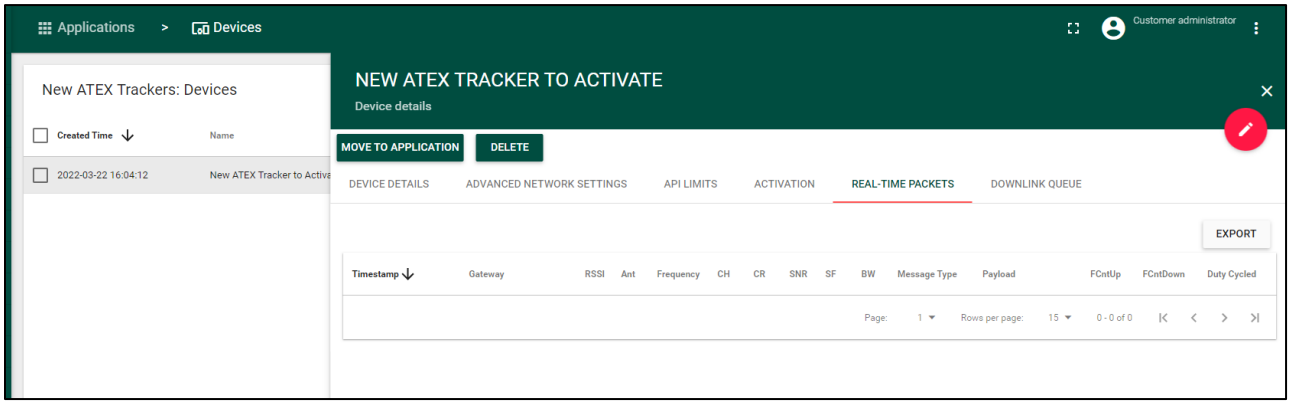

Figure 5: New ORCA *Real-Time Packets* View on the Network Server

6. Locate the magnetic activation site on the enclosure as shown in Figure 6. The site is located on the bottom of the main body of the enclosure and is marked with a magnet symbol.

Figure 6: Magnetic Activation Site

7. Place the included magnet against the enclosure at the magnetic activation site. Using a stopwatch to verify, keep the magnet in contact for **5 seconds**. Remove the magnet entirely after 5 seconds. Immediately after removing the magnet, the GREEN LED should blink 3 times, then the standard join process should begin.
8. The proper UL/DL exchange that indicates a successful reconfiguration is as follows:
    a. ↑ Join Request UL
    b. ↓ Join Accept DL
    c. ↑ UL0
    d. ↓ DL0 containing the channel mask, DR1 setting, and TxPower 0 setting
    e. ↑ UL1 containing a 4-byte CRC acknowledging the configuration settings in DL0 were successfully applied
    f. ↓ DL1 containing the optional application configuration settings (in this example the GPS data reporting period was changed) and saves all configuration settings to flash memory
    g. ↑ UL2 containing a 4-byte CRC acknowledging the configuration settings in DL1 were successfully applied

h. ↓ DL2 containing the command to disable ADR on the device-level

i. ↑ UL3 containing a 4-byte CRC acknowledging the configuration settings in DL2 were successfully applied

j. ↑ UL4 and beyond are regular application data ULs.

This sequence is shown in Figure 7. Note that in this case, there are 2 copies of each UL because each UL was picked up by 2 different GWs in use. In this example, the ORCA joined at DR4 (as indicated by UL0 having SF8 and BW 500 kHz). After DL0 was received, the device successfully switched to operate at DR1 (as indicated by all subsequent messages being sent with SF9).

Timestamp ↓	Gateway	RSSI	Ant	Frequency	CH	CR	SNR	SF	BW	Message Type	Payload	FCntUp	FCntDown
2022-09-30 15:11:30	647FDAFFFE0107DF	-107	0	902.9	3	4/5	10.8	9	125	Uplink	QEMK4W8ABAAK+3qsI5:	4	
2022-09-30 15:11:24	647FDAFFFE0107DF	-111	0	903.7	7	4/5	9.8	9	125	Uplink	QEMK4W8AAwBkCTHHN	3	
2022-09-30 15:11:24	647FDAFFFE007E00	-72	0	903.7	7	4/5	11	9	125	Uplink	QEMK4W8AAwBkCTHHN	3	
2022-09-30 15:11:23	647FDAFFFE007E00		0	926.9	6	4/5		9	500	Downlink	YEMK4W+AAgBk3Vmtwł		2
2022-09-30 15:11:23	647FDAFFFE007E00	-73	0	903.5	6	4/5	11	9	125	Uplink	QEMK4W+AAgBkeZA6fnl	2	
2022-09-30 15:11:23	647FDAFFFE0107DF	-113	0	903.5	6	4/5	9.8	9	125	Uplink	QEMK4W+AAgBkeZA6fnl	2	
2022-09-30 15:11:22	647FDAFFFE007E00		0	923.3	0	4/5		9	500	Downlink	YEMK4W+QAQBkFD+jeY:		1
2022-09-30 15:11:22	647FDAFFFE007E00	-71	0	902.3	0	4/5	11	9	125	Uplink	QEMK4W+EAQADBwMH:	1	
2022-09-30 15:11:22	647FDAFFFE0107DF	-111	0	902.3	0	4/5	9.2	9	125	Uplink	QEMK4W+EAQADBwMH:	1	
2022-09-30 15:11:18	647FDAFFFE007E00		0	923.3	8	4/5		7	500	Downlink	YEMK4W+6AAADQAEAc(		0
2022-09-30 15:11:18	647FDAFFFE007E00	-67	0	903	8	4/5	10	8	500	Uplink	gEMK4W+AAABjnIgd	0	
2022-09-30 15:11:18	647FDAFFFE0107DF	-107	0	903	8	4/5	7.2	8	500	Uplink	gEMK4W+AAABjnIgd	0	
2022-09-30 15:11:14	647FDAFFFE007E00		0	923.3	8	4/5		7	500	Join Accept	IOIQkojSdXs47An1x/QM7		
2022-09-30 15:11:14	647FDAFFFE007E00	-74	0	903	8	4/5	11	8	500	Join Request	AAAAABCA2n9kjKYAAAI		

Figure 7: Proper UL/DL Sequence for ORCAs Joining the Network

NOTE: After this UL/DL exchange, the ORCA should operate normally at DR1 for the rest of the time it spends joined to the network in the current session. If at any point the ORCA restarts and joins the network again, it is recommended that the 3rd DL command (that disables ADR on the device-level) be queued and sent to the device again without saving this configuration to flash.

This is not saved so that when the device rejoins for whatever reason, the ADR is enabled when it joins so that it can apply the proper channel mask. If ADR is disabled at the time of join, PSR will decrease as explained in the *Background on LoRaWAN* section above.

References

[1] LoRa Alliance, Inc., "LoRaWAN Specification 1.0.2," July 2016. [Online]. Available: https://lora-alliance.org/wp-content/uploads/2020/11/lorawan1_0_2-20161012_1398_1.pdf. [Accessed 30 September 2022].

[2] TEKTELIC Communications Inc, ORCA Industrial GPS Asset Tracker Technical Reference Manual v0.13, Calgary: TEKTELIC, 2022.