# ARA RF Advanced Front End (ARAFE): Slave Communication Document

This document details the communication protocol to the ARA RF Advanced Front End (ARAFE) slave (quad) modules. This communication protocol is typically performed by the ARAFE Master, in response to commands from software.

## Overall Physical Layer

The ARAFE slave communication is performed over the +15V DC power supply line, using an on-off keying (OOK) signaling mechanism at approximately 1 MHz. “On” is interpreted as a digital 0, and “off” is interpreted as a digital 1. Characters are then sent as a typical UART, at 9600 bps, 8 bits, no parity, and 1 stop bit.

## Packets from Master (bytes)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ‘!’ | ‘M’ | ‘!’ | command | argument | 0xFF |

## Responses from Slave (bytes)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ‘!’ | ‘S’ | ‘!’ | ack | 0xFF |

## Normal Commands (command 0-15)

|  |  |  |
| --- | --- | --- |
| **Command** | **Argument** | **Description** |
| 0 | 0-127 | Set signal attenuator on channel 0 |
| 1 | 0-127 | Set signal attenuator on channel 1 |
| 2 | 0-127 | Set signal attenuator on channel 2 |
| 3 | 0-127 | Set signal attenuator on channel 3 |
| 4 | 0-127 | Set trigger attenuator on channel 0 |
| 5 | 0-127 | Set trigger attenuator on channel 1 |
| 6 | 0-127 | Set trigger attenuator on channel 2 |
| 7 | 0-127 | Set trigger attenuator on channel 3 |
| 8 | 0,1 | Turn on/off 12V for channel 0 |
| 9 | 0,1 | Turn on/off 12V for channel 1 |
| 10 | 0,1 | Turn on/off 12V for channel 2 |
| 11 | 0,1 | Turn on/off 12V for channel 3 |
| 12 |  | *Unused* |
| 13 | 0,1 | Turn on/off 5V |
| 14 | 0,1 | Turn on/off 12V |
| 15 | 0,1 | Turn on/off both 5V and 12V |

## Device Info

Each ARAFE quad has a 16-byte ‘device info’ structure, which contains the default settings for the attenuators as well as the default power on/off behavior.

These can be written to (for index < 12) and read from, and then stored permanently in flash so that initial power on behavior can be controlled.

### Device Info Table

|  |  |
| --- | --- |
| **Index** | **Description** |
| 0 | Default signal attenuator value for channel 0 |
| 1 | Default signal attenuator value for channel 1 |
| 2 | Default signal attenuator value for channel 2 |
| 3 | Default signal attenuator value for channel 3 |
| 4 | Default trigger attenuator value for channel 0 |
| 5 | Default trigger attenuator value for channel 1 |
| 6 | Default trigger attenuator value for channel 2 |
| 7 | Default trigger attenuator value for channel 3 |
| 8 | Default P2OUT value (see text) |
| 9 | Default P3OUT value (see text) |
| 10 | Serial number MSB |
| 11 | Serial number LSB |
| 12 | Major firmware version |
| 13 | Minor firmware version |
| 14 | 0x12 |
| 15 | 0x34 |

The P2OUT and P3OUT values control which voltages are enabled automatically at power on. Note that improperly programming these values may cause some problems with the default attenuator programming, but most likely not. (In detail, P2OUT/P3OUT can also set the LE pin for each attenuator, which is supposed to be pulsed high after the data is clocked in. The LE pin is set low at the beginning, so this should not cause problems, but there is some possibility).

### Default Power Enable Locations

|  |  |
| --- | --- |
| **Voltage** | **Bit to Set to Turn On By Default** |
| 5V | P3OUT | 0x1 |
| 12V | P3OUT | 0x80 |
| 12V 0 | P3OUT | 0x40 |
| 12V 1 | P3OUT | 0x10 |
| 12V 2 | P3OUT | 0x08 |
| 12V 3 | P2OUT | 0x01 |

By default, the +5V and +12V turn on automatically. **None** of the 12V 0/1/2/3 turn on to prevent DC voltage from being present on the RF input (via the bias tee) by default.

### Writing/Reading/Flashing Device Info

To **write** to the device info, the command should be a bitwise OR of 0x80 with the device info address, and the argument should be the value. That is, to write 0x12 to device info 10, you would send command = 0x80 | (10), and argument = 0x12.

To **read** from the device info, the command should be a bitwise OR of 0x40 with the device info address. The argument is unused. The value read from the device info is contained in the *ack* byte.

To **flash** the device info, send command 0x20.

## Housekeeping

There are 3 sensors in the ARAFE slave, and 4 possible housekeeping commands. The sensors are *nominally* 10 bits, but only 1 byte is returned with each command. The most significant 8 bits are returned with each sensor read, and the low 2 bits can be obtained with a 0x14 command.

|  |  |
| --- | --- |
| **Command** | **Return ‘ack’ value** |
| 0x10 | MSP430 temperature, top 8 bits |
| 0x11 | +5V current, top 8 bits |
| 0x12 | +12V current, top 8 bits |
| 0x13 | Fault detection (Fault if very low if 0x12 is high), top 8 bits |
| 0x14 | Low 2 bits of last conversion |

The fault detection circuit works by comparing the value read with the +12V current.

* +12V current roughly 0, fault detection > 0: **no fault** and **no current**
* +12V current roughly 0, fault detection roughly 0: **fault** on one of the outputs
* +12V current above 0, fault detection above 0: **normal operation**

The remaining case (+12V current above 0, fault detection 0) should never occur.