## Product Description

The C410/420 (C4xx) are Power Components which are customizable sequencers and designed to be used in the AmP™ platform.  Combine the C4xx component with other Power Components to create a custom-defined, AnDAPT AmP on-demand power management device. The C420 should be used when the user needs to sequence 4 Synchronous Bucks or when the user needs greater than 4 ms sequence delays, else use the C410.

## Features

- Adjustable, programmable sequencer
- Up to eight independent input and output controls
- Connect inputs and outputs to status outputs and control inputs on other regulators or switches
- Cascadable with selectable dependencies
- Adjustable delays:
  - C410 up to 4ms,
  - C420 up to 160,000 ms

## Block Diagram

Figure 1 provides a block diagram for the C410 Power Components when integrated with other power rails in an AmP application. Signal names alternate in color on Group boundaries.

*Figure 1: C410 and C420 application schematics*
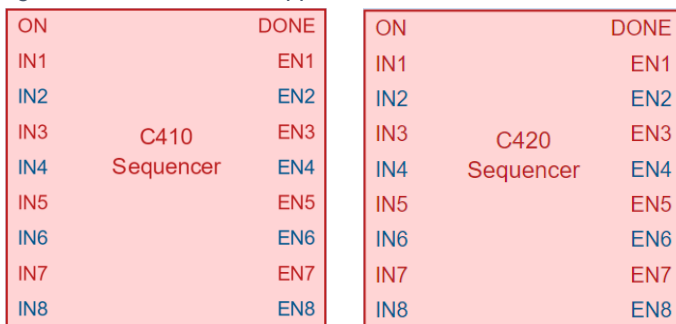


## Description

The C410/C420 Power Component is a customizable Sequencer. Combine the C410 component with other Power Components to create a highly-integrated, custom-defined, AnDAPT AmP™ on-demand power management device.

The C4xx component provides a customizable number of sequencer inputs and outputs with customizable dependencies and customizable delays between each sequence step, ranging from 0.25 ms to 4 ms in the C410 and 0.2 ms to 160,000 ms in the C420.  The inputs and outputs connect to various control inputs and status outputs of the regulators and switches in the application. These customizable values are specified by the power engineer using AnDAPT's cloud-based WebAmp™ development software.

The C410 utilizes Compensation Memory resources while the C420 does not. The C410 uses less LUT fabric resources than the C420. (see Resource Utilization section, page 4). As 4 Synchronous Bucks utilize all the Compensation Memory resources, the C420 must be used in this case. If sequence delays are greater than 4 ms, use the C420.

## Customizable Options

Table 1 lists the various customizable options available for the C410 Power Components.  These options are set graphically in the WebAmp development software.

*Table 1: C410 Customizable Options*

| Option |
| --- |
| Enable input (ON) |
| Number of trigger inputs |
| Number of outputs |
| Groups |
| Channels |
| Sequencer dependency |
| Delay on each output |
| Sequence complete output (DONE) |

## System Characteristics

*Table 2: C410 System Characteristics*

| Parameters | | Min | Max | Units |
| --- | --- | --- | --- | --- |
| **Control** | | | | |
| Delay from input to output, each output | C410 | 0.25 | 4 | ms |
| | C420 | 0.20 | 160,000 | ms |

## Fault Conditions

A PGood condition that de-asserts before all sequences are complete (DONE signal high), results in a shut-down sequence. It is the responsibility of the controller driving the ON signal to monitor for time out in the event DONE never goes high. In that case ON must be toggled low to restart the sequence.  PGood signals going low after done initiates a normal shut-down sequence ending with DONE going low.

Sequencer behavior may be affected when Telemetry Interfaces I480 or P480 disable the EN inputs to I or P series Power Components.

For other device specifications, see the AnDAPT AmP Platform datasheet.

## Sequencer Parameter entry

The C410 allows up to eight channels allocated over up to eight groups selected with delays of 0.25 to 4 ms each.

*Figure 2: C410 Sequencer Parameter entry: Eight Groups, Eight Channels*

The C420 allows up to eight channels allocated over up to eight groups selected with delays of 0.2 to 160,000 ms each.

*Figure 3: C420 Sequencer Parameter entry: Eight Groups, Eight Channels*

**Sequencer**

| | Channels | Delays (ms) |
|---|---|---|
| Group 1 | 1 | 0.25 |
| Group 2 | 1 | 0.25 |
| Group 3 | 1 | 0.25 |
| Group 4 | 1 | 0.25 |
| Group 5 | 1 | 0.25 |
| Group 6 | 1 | 0.25 |
| Group 7 | 1 | 0.25 |
| Group 8 | 1 | 0.25 |

**Sequencer**

**POL Specification**

| | |
|---|---|
| Number of POLs | 8 |
| Number of Seq. Groups | 8 |

**Time Specification**

| | | |
|---|---|---|
| Time Step | 1 | ms |
| Number of Steps | 4 | ▼ |
| Maximum Delay | 4 | ms |

**Delays**

| | Channels | Target Delay ms | Actual Delay ms |
|---|---|---|---|
| Group 1 | 1 | 4 | 4 |
| Group 2 | 1 | 4 | 4 |
| Group 3 | 1 | 4 | 4 |
| Group 4 | 1 | 4 | 4 |
| Group 5 | 1 | 4 | 4 |
| Group 6 | 1 | 4 | 4 |
| Group 7 | 1 | 4 | 4 |
| Group 8 | 1 | 4 | 4 |

# Application Example, Two Groups, two Channels

The C410 Sequencer application example, Figure 6, sequences a C750 Load Switch with a C710 LDO. When ON pin 24 is asserted high, C410/C420 Sequencer asserts EN1 high after Group 1, Delay1, 0.25 ms as shown in Figure 5 and specified in Parameters entry, Figure 4. When C750 Load Switch determines that power is good, it asserts PGood1 connected to Sequencer IN1. After specified Group 2 Delay2, 0.25 ms the C410/C420 Sequencer asserts EN2, enabling C710 LDO. When C710, LDO determines that power is good, it asserts PGood2 connected to Sequencer IN2. Then C410/C420 Sequencer asserts DONE high, completing the turn on sequence. When ON pin 24 is asserted low, C410/C420 Sequencer, in reverse order, sequences down until DONE is asserted low, completing the turn off sequence.

*Figure 4: C410/C420 Sequencer Parameter entry: Two Groups, two Channels*



*Figure 5: C410/C420 Sequencer example waveform Two Groups, two Channels*
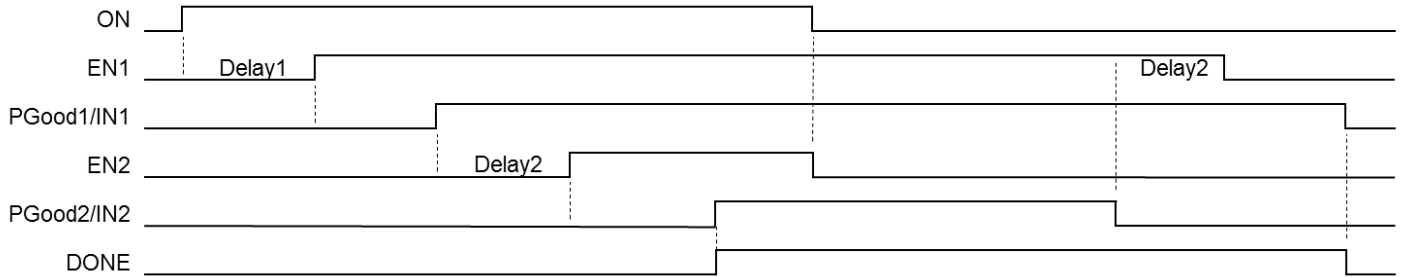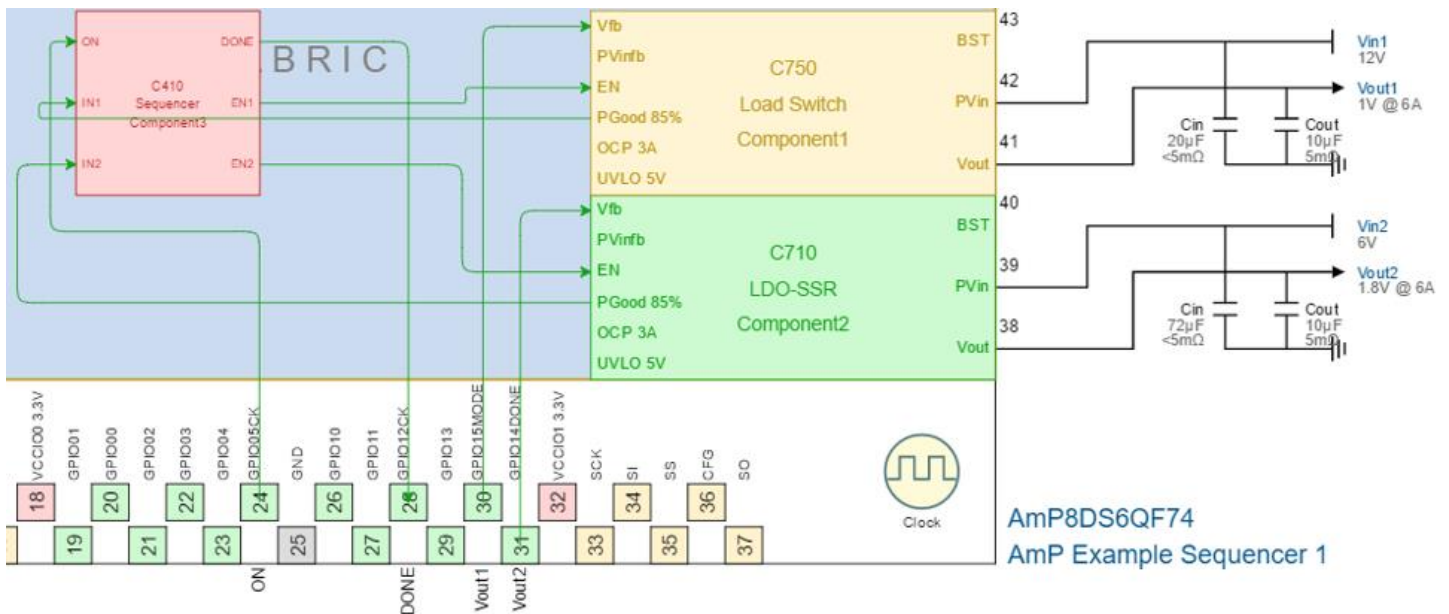


*Figure 6: C410/C420 Sequencer example schematic Two Groups, two Channels*

## C410 Resource Usage for 8 channels

Circuit Stats...
```
        Number of AnD_ATC_IO          18
        Number of AnD_PMT     1
        Number of AnD_CM_PID          1
        Number of AnD_PTG_Phase_Count      1
        Number of AnD_PTG_GBUF    1
        Number of AnD_PTG_OSC     1
        Number of AnD_DFFN  6
        Number of AnD_DFF    7
        Number of LUT4        54
```

Resource Usage...
```
        io        18 used (Capacity  24)
        clb       7 used (Capacity  64)
        cm        1 used (Capacity  8)
        pmt       1 used (Capacity  16)
        ptg       1 used (Capacity  2)
        uLogic    54 used (Capacity 512)
```
Components Stats...
```
        $techmap\component_1
                AnD_DFF      7
                AnD_DFFN     6

        component_1
                AnD_CM_PID   1
                AnD_PMT      1
```

## C420 Resource Usage for 8 channels

Circuit Stats...
```
        Number of AnD_ATC_IO          18
        Number of AnD_PMT     1

        Number of AnD_PTG_Phase_Count      1
        Number of AnD_PTG_GBUF    1
        Number of AnD_PTG_OSC     1
        Number of AnD_DFF     17

        Number of LUT4        64
```

Resource Usage...
```
        io        18 used (Capacity  24)
        clb       8 used (Capacity  64)

        pmt       1 used (Capacity  16)
        ptg       1 used (Capacity  2)
        uLogic    64 used (Capacity 512)
```
Components Stats...
```
        $techmap\component_1
                AnD_DFF          17

        component_1
                AnD_PMT        1
```