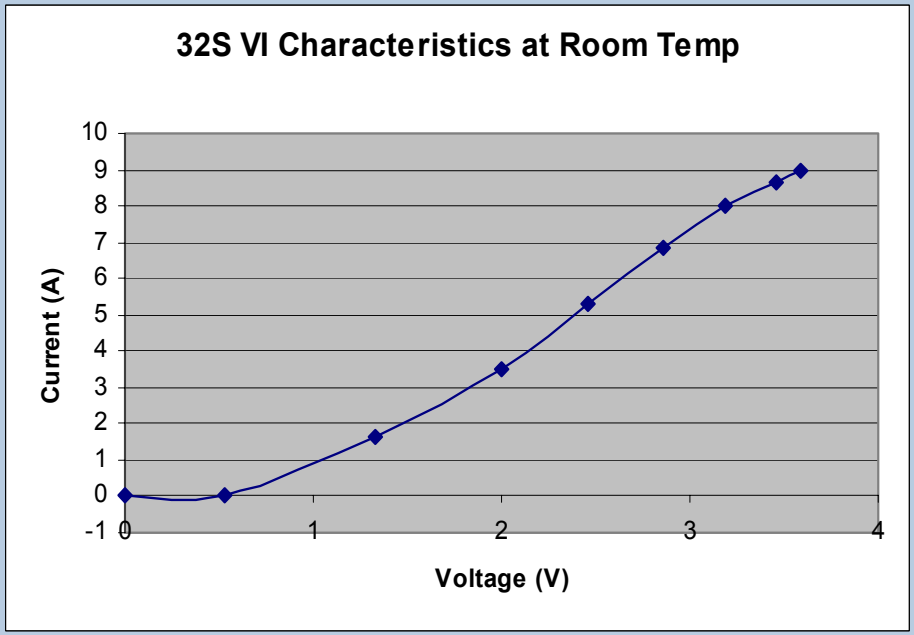
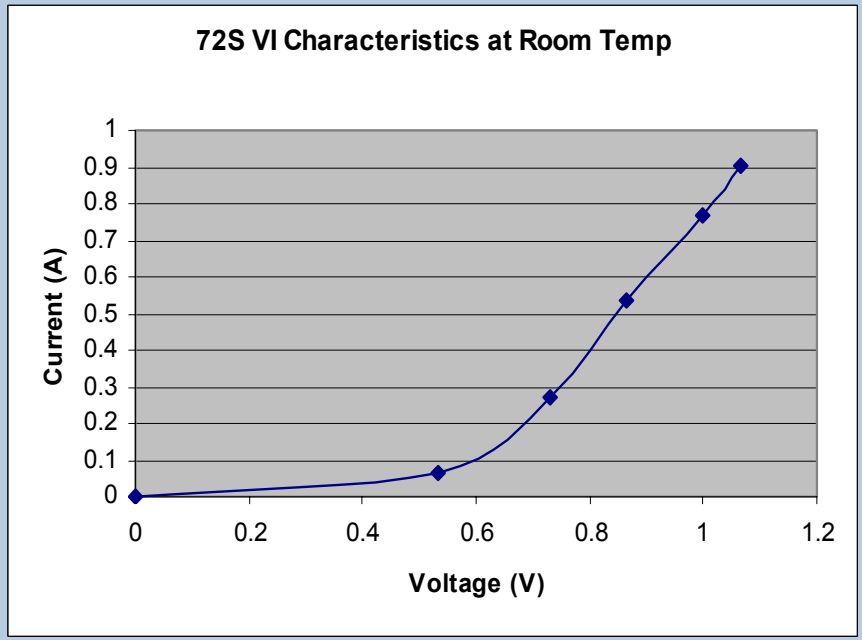
Inrush Current Data

July 28, 2003

Room temperature (VCCI vs inrush current at 5sec cycle)



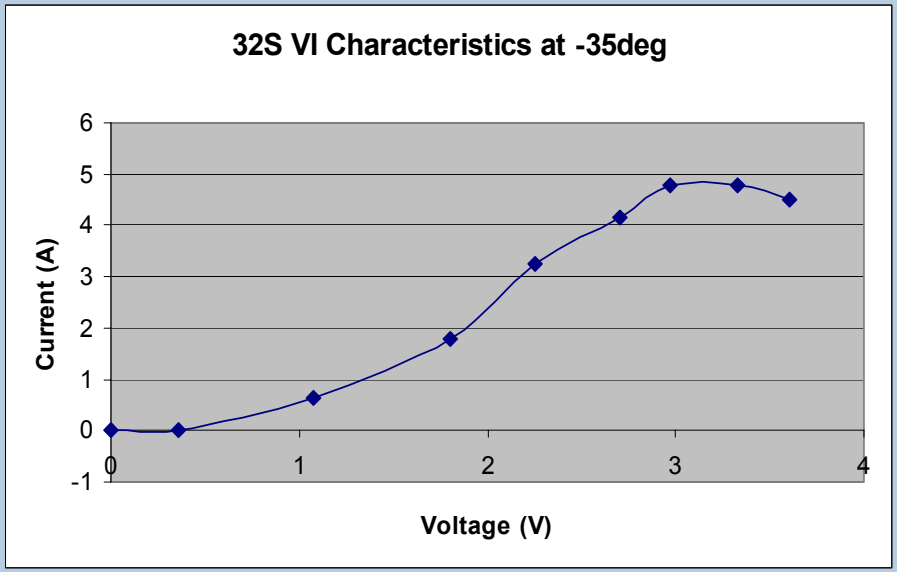
SN21975



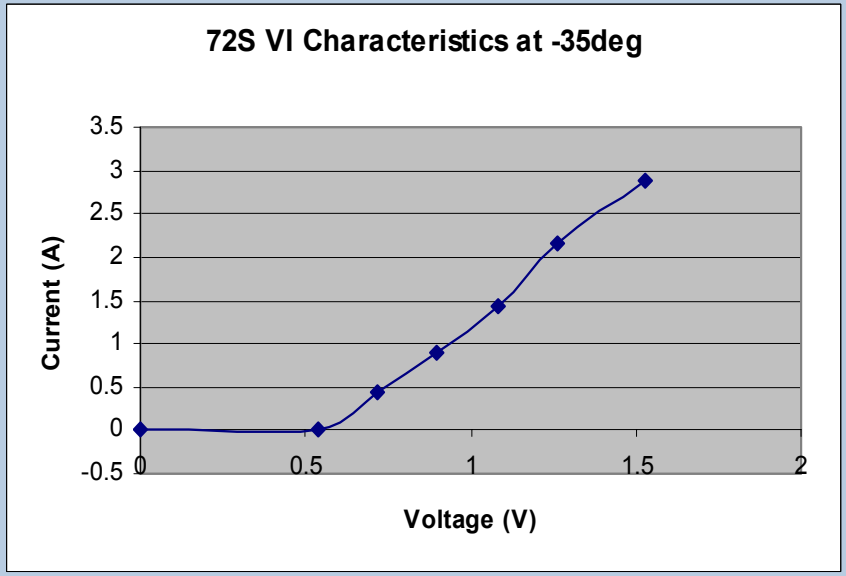
SN7398

If V_{CCI} and V_{CCA} are simultaneous you will see virtually no inrush current. Simultaneous being up to a few microseconds of separation. In this case V_{CCA} should be just at 0.7V when V_{CCI} is at 1 volt (1 Amp)

Cold temperature (VCCI vs inrush current at 5sec cycle)



SN21975



SN7398

See previous page comments

Issues – Inrush Current
EM Analysis Supplies

Electromigration Analysis:

Analysis for the V_{CCI} supply pads:

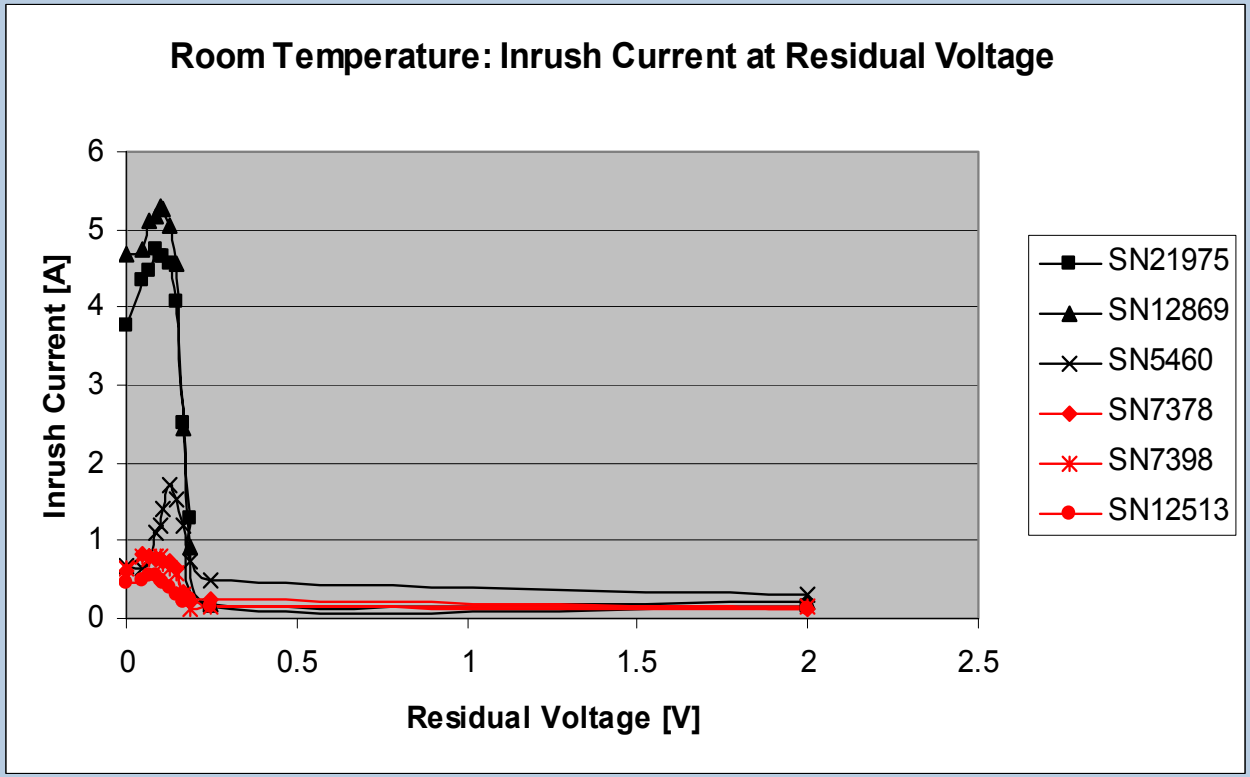
- Using V_{CCI} pins as the limiting factor for the EM concerns:
  - Actel design rules allow 116mA per V_{CCI} pin for continuous operation over 20yrs at 105C
  - With 16 V_{CCI} pads on RTSX32S, this means that we can have:
    - 16 x 116mA = 1.86A of continuous device I_{CCI} current for 20 years
- With a 10A continuous current life time decreases 25x to 0.8yrs
  - This is equivalent to 3.55e9 power cycles using a 7ms cycle time
  - Another view of this is 20,285 cycles/hr

Issues – Inrush Current
EM Analysis Output buffers

Analysis for the output buffers:

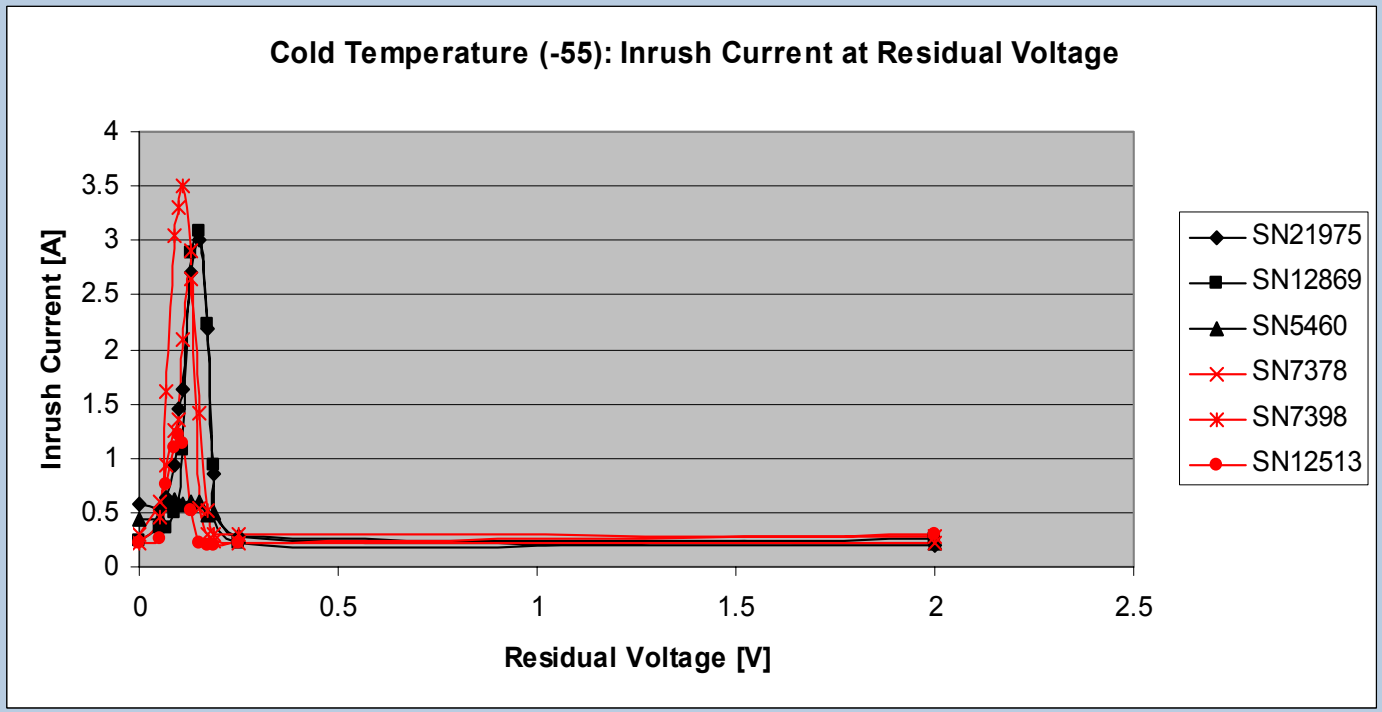
- SPICE simulation results show 83mA per I/O with V_{CCI} = 3.6V (@105C)
  - 83mA on 4 M1 metal segments yielding 21mA per segment
  - Each segment is 13.4um or 1.57mA/um on M1.
  - This is 3.5X of the Actel design rule of 0.45mA/um for M1
  - Lifetime decreases by 12X to 1.65 years
    - This (1.65 yrs) is equivalent to 7.2e9 power cycles using a 7ms cycle time
    - Another view of this is 42,400 cycles/hr
- What kind of an application might power cycle the device at these kinds of numbers for its lifetime?
  - Such an application must have V_{CCA} lead V_{CCI}!

Room temperature (Inrush vs residual voltage, at 5sec cycle)



Black = RTSX32S, Red = RTSX72S

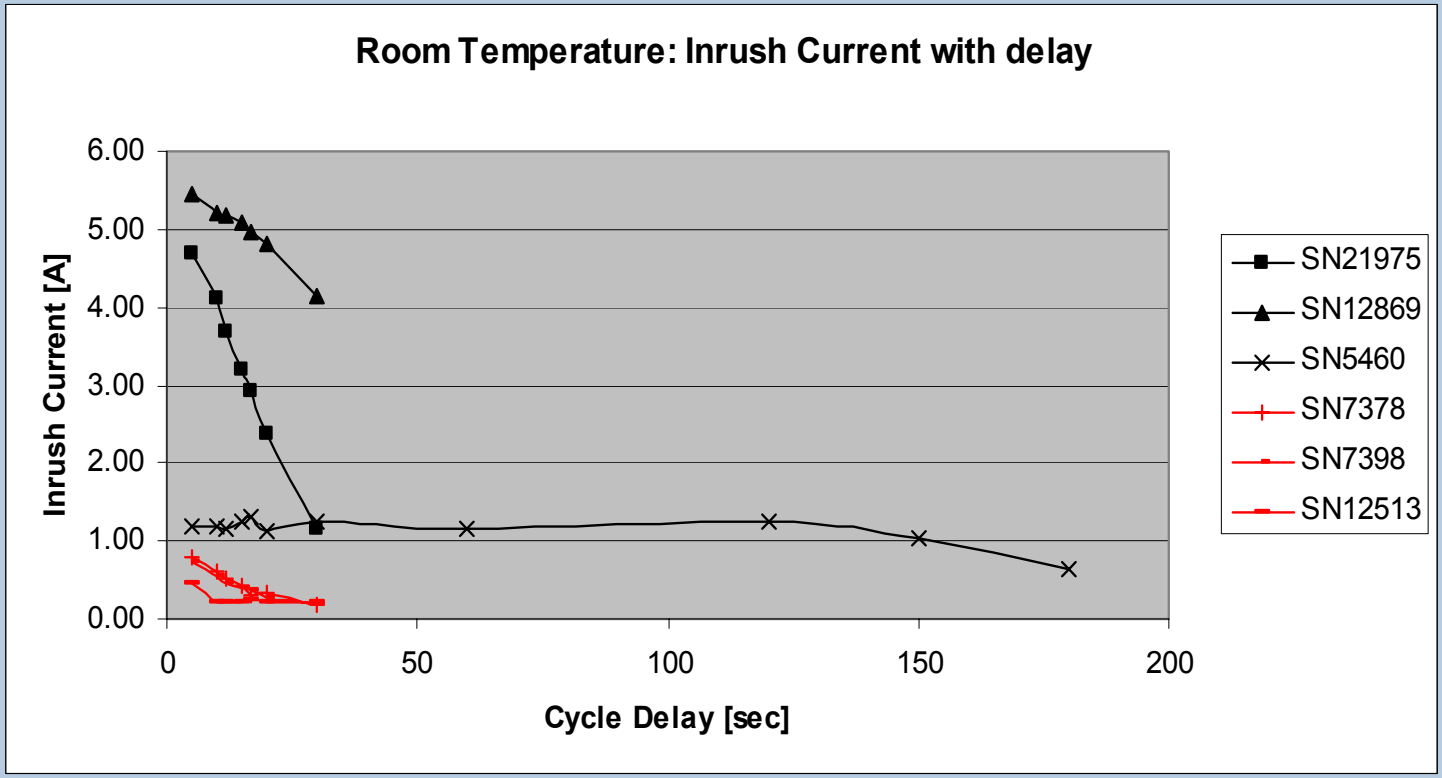
Cold temperature (Inrush vs residual voltage, at 5sec cycle)



Black = RTSX32S, Red = RTSX72S

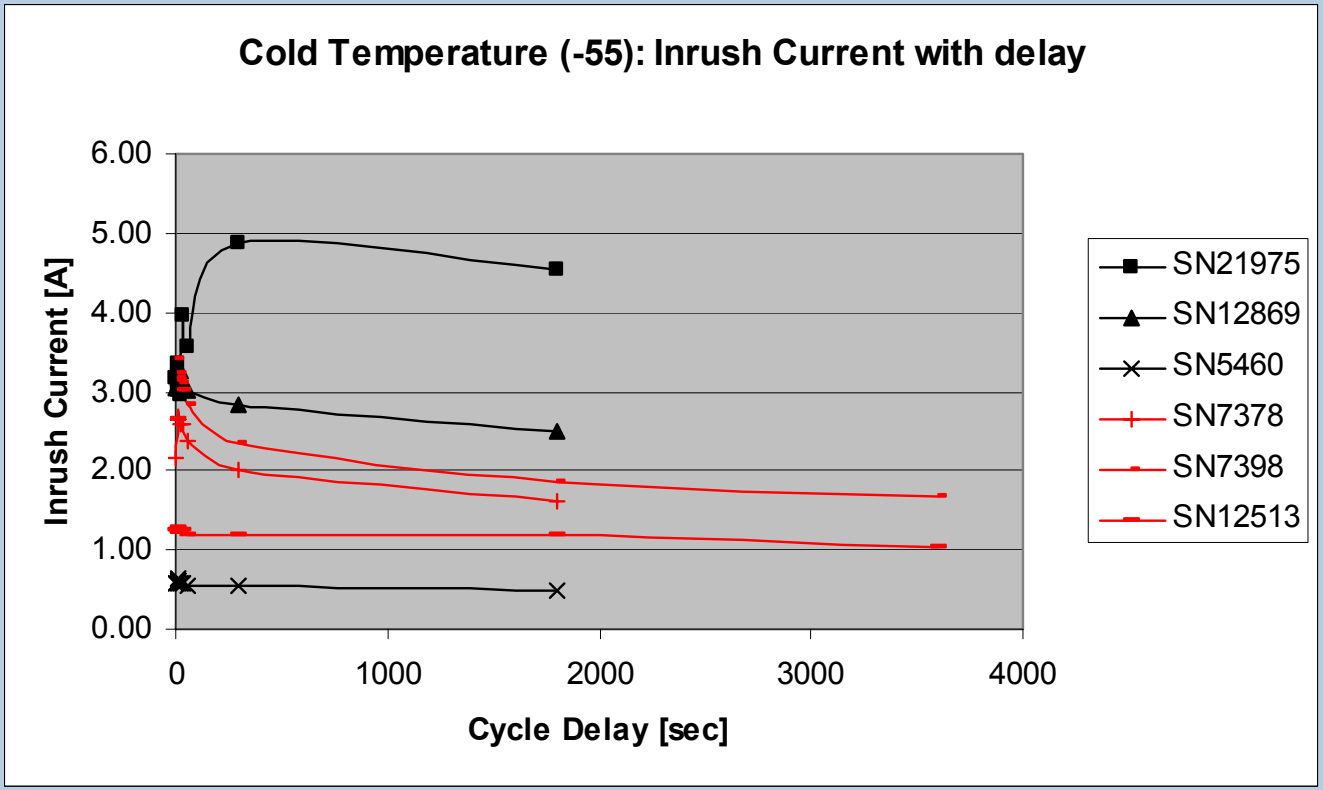
Increased current with the RTSX-72S than previously published

Room temperature (Inrush vs cycle delay, at 0.1V residual)



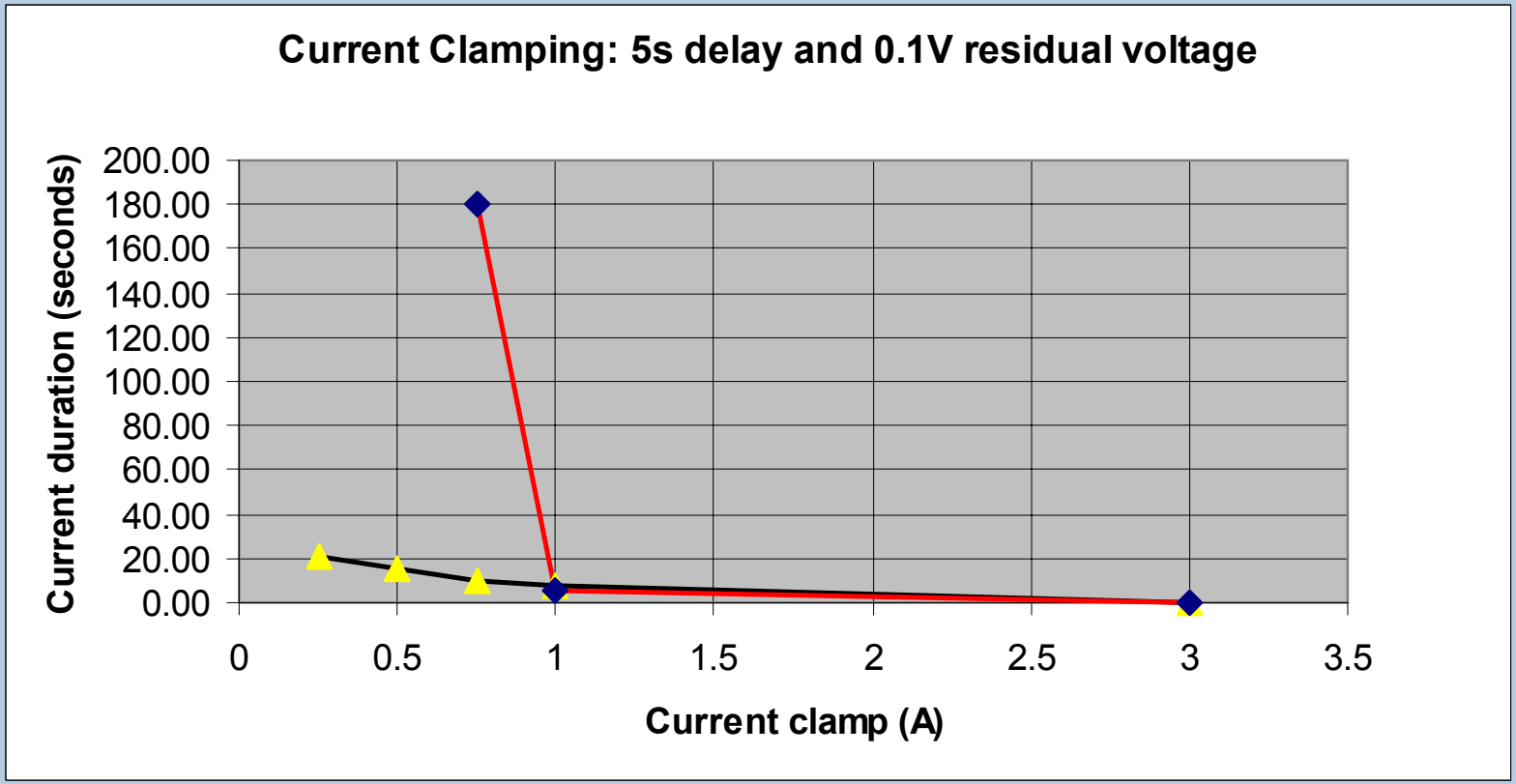
Black = RTSX32S, Red = RTSX72S

Cold temperature (Inrush vs cycle delay, at 0.1V residual)



Black = RTSX32S, Red = RTSX72S

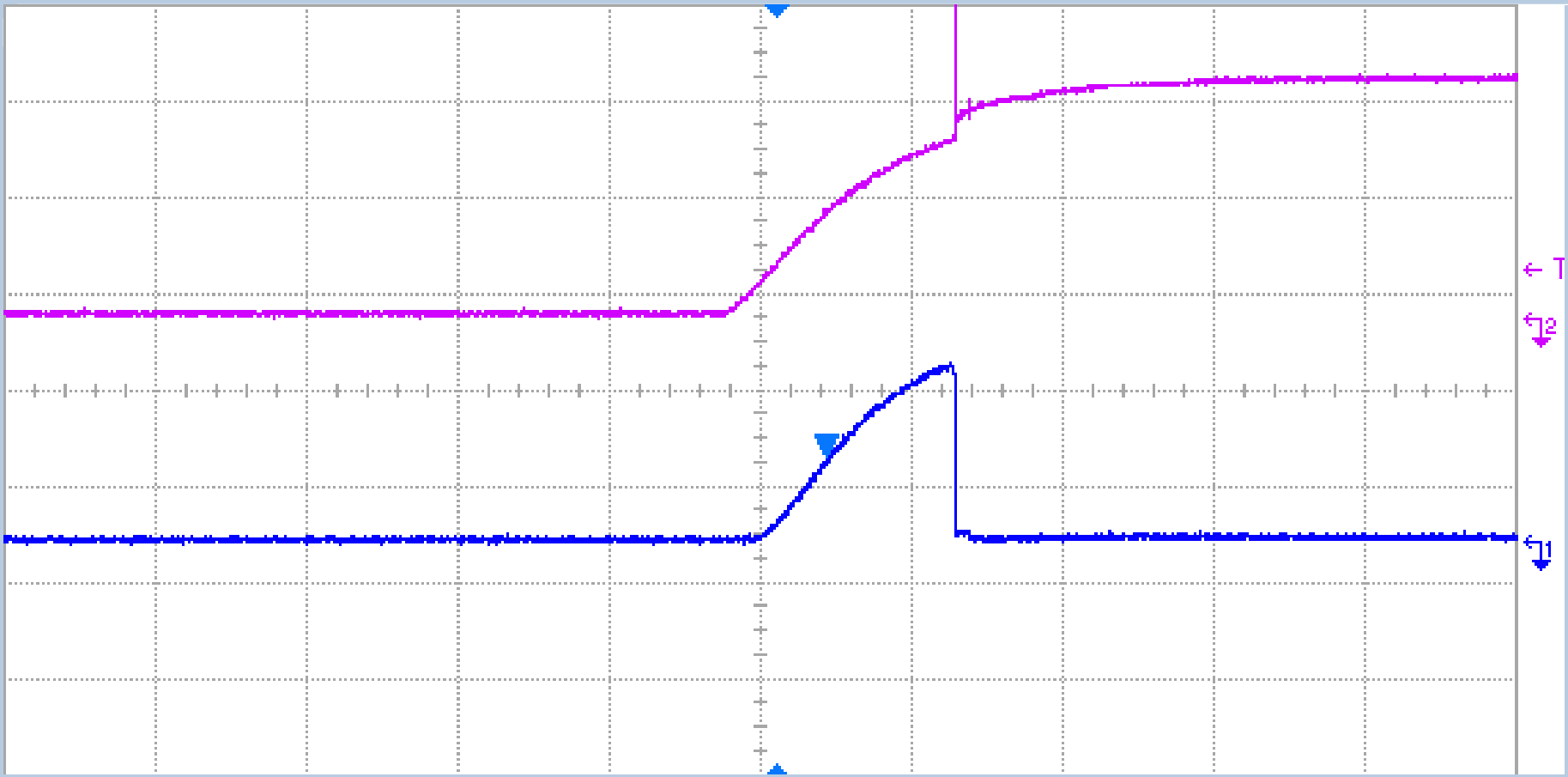
Inrush duration vs current clamp on VCCI (RTSX32S)



Black = RoomTemp, Red = -35C

SN21975

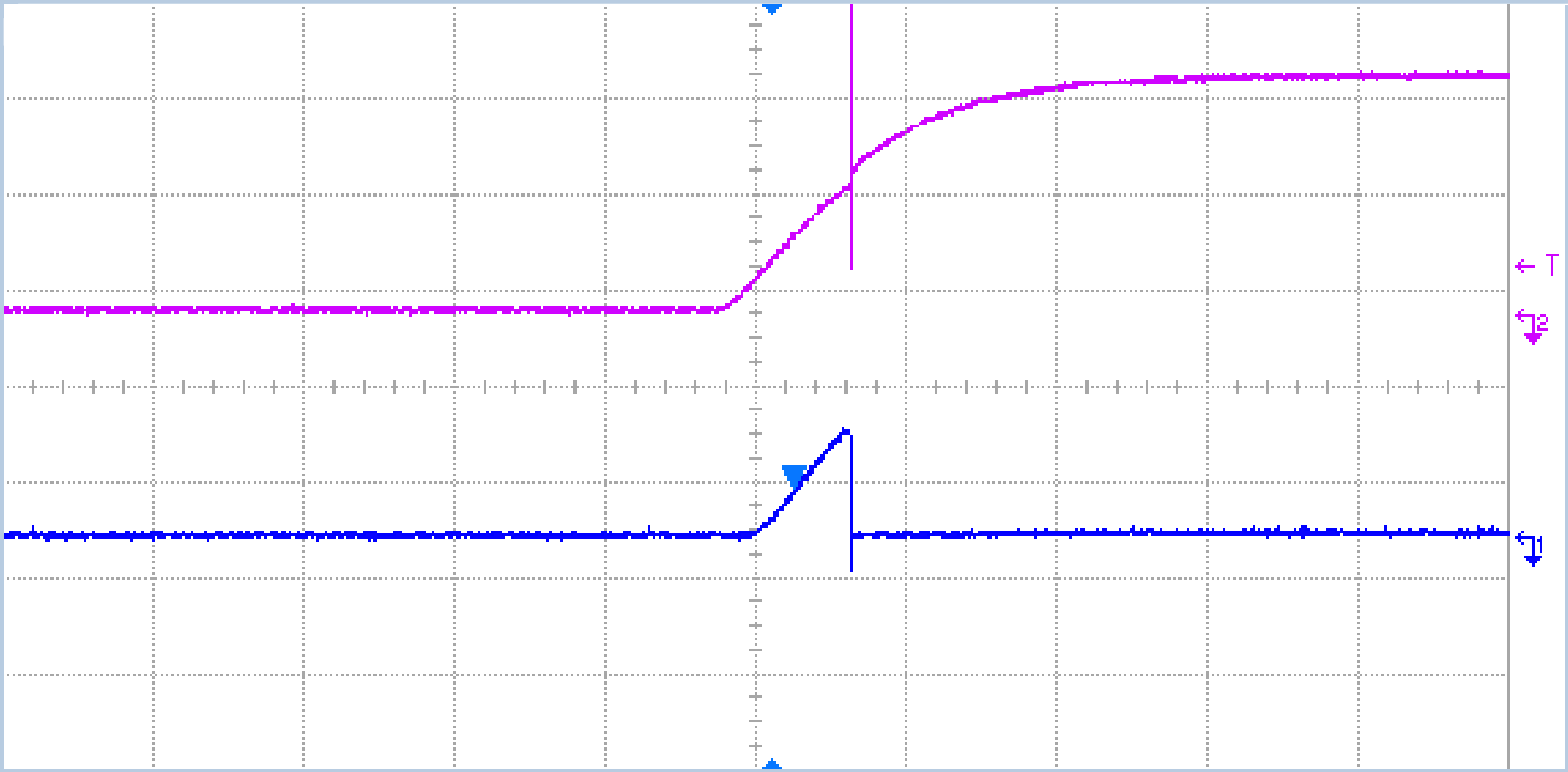
RT54SX32S with 5s cycle (SN21975 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (5A/div)

VCCA = 0V

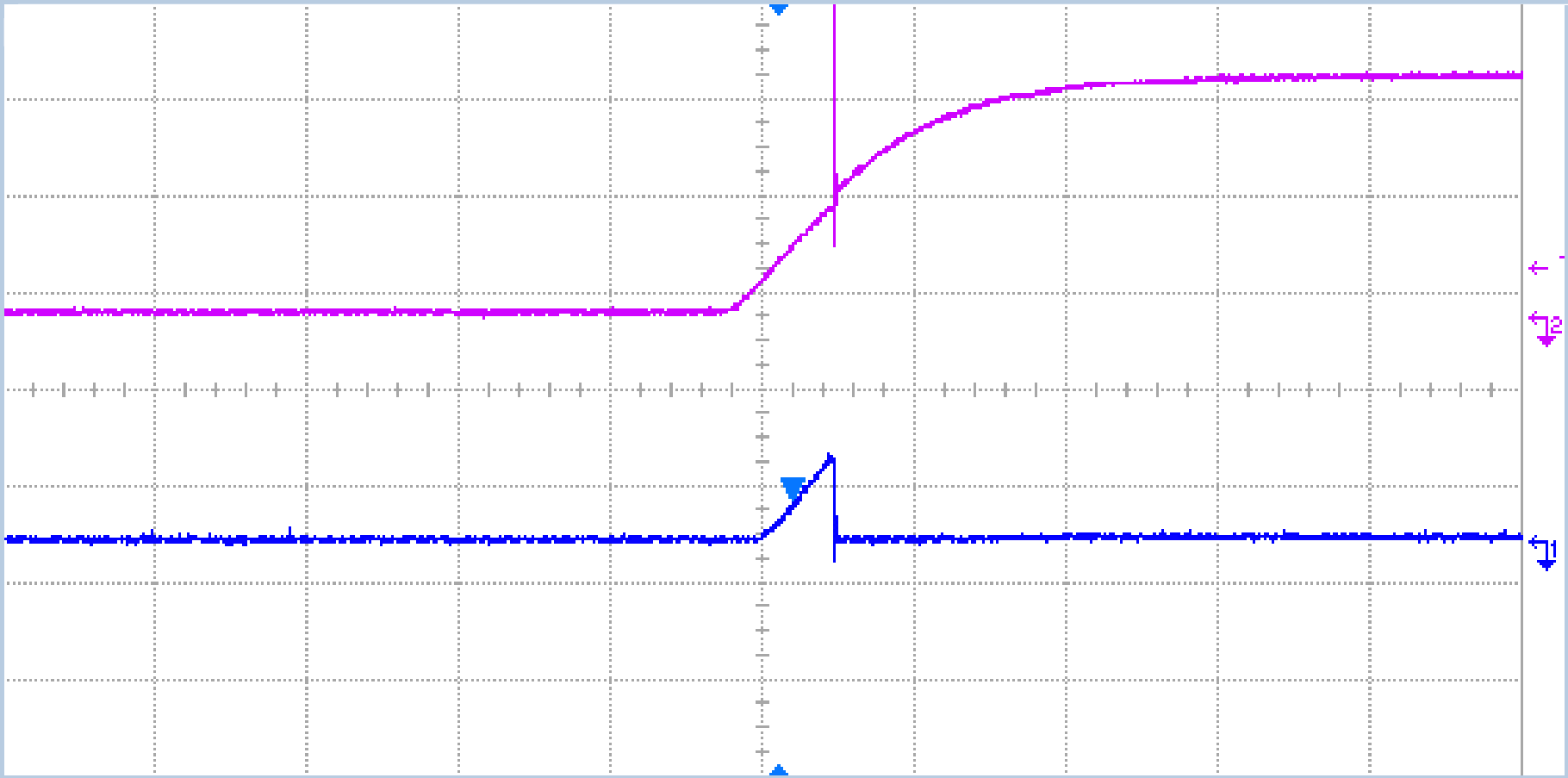
RT54SX32S with 10s cycle (SN21975 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (5A/div)

VCCA = 0V

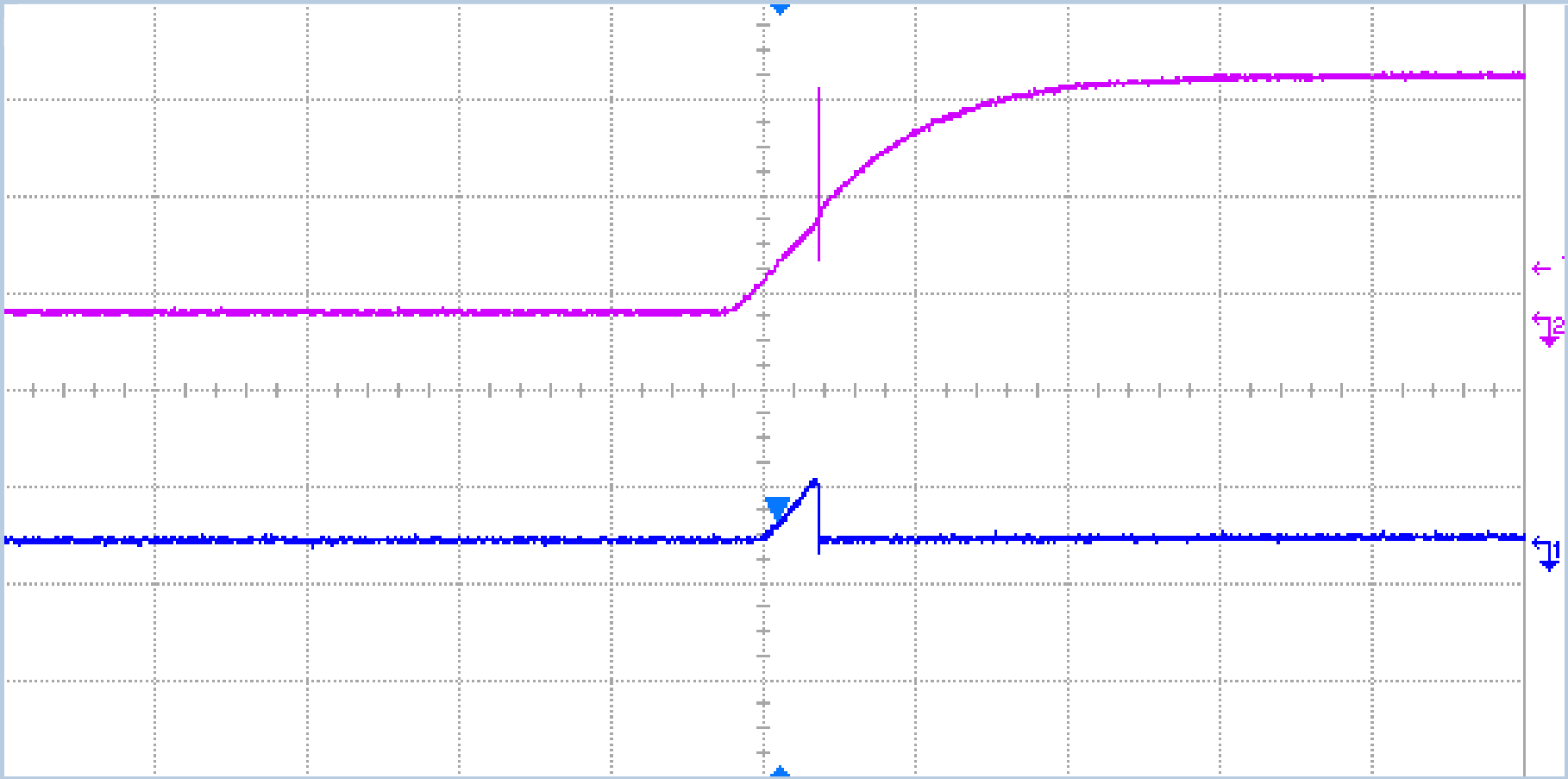
RT54SX32S with 15s cycle (SN21975 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (5A/div)

VCCA = 0V

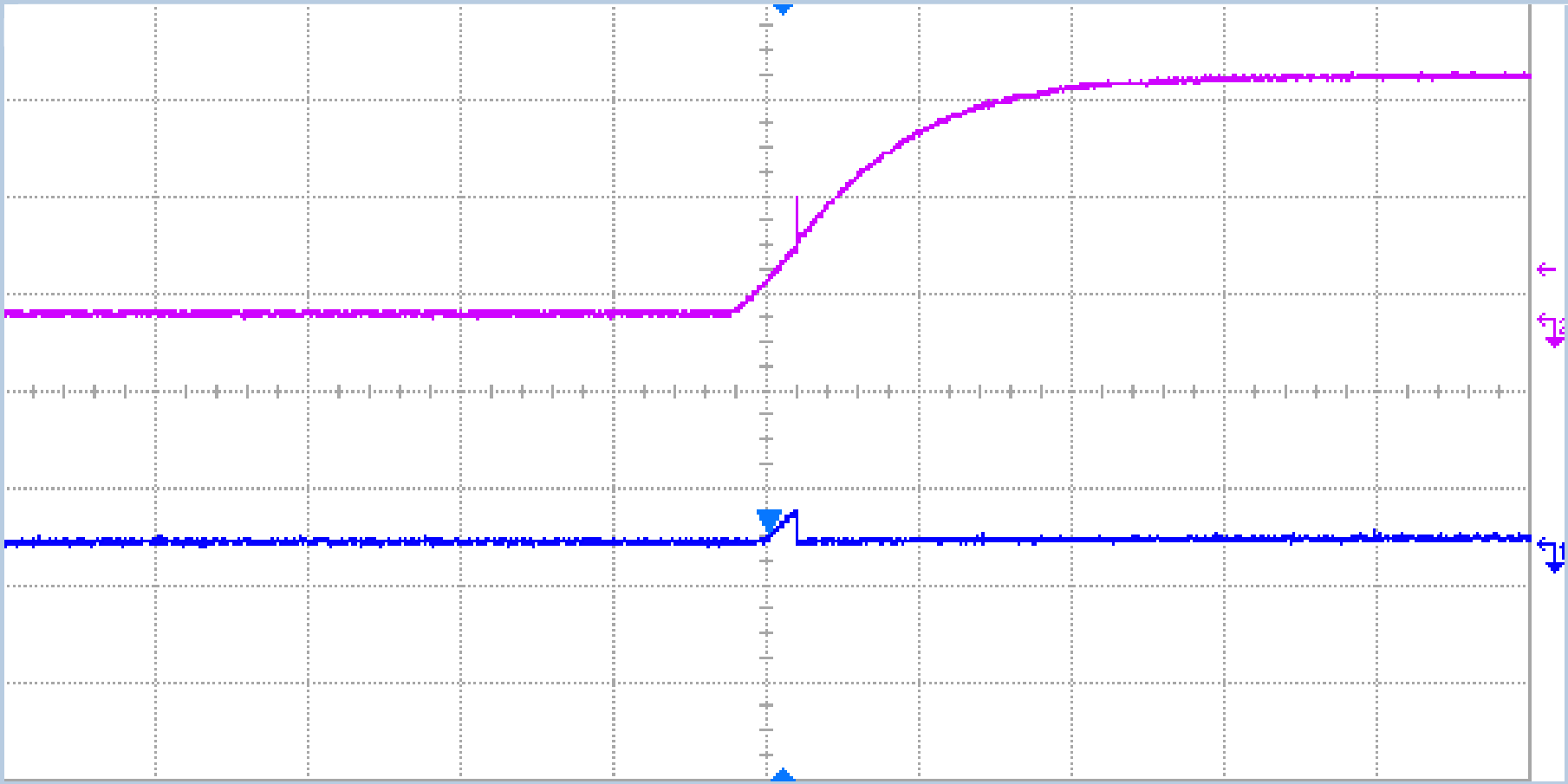
RT54SX32S with 20s cycle (SN21975 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (5A/div)

VCCA = 0V

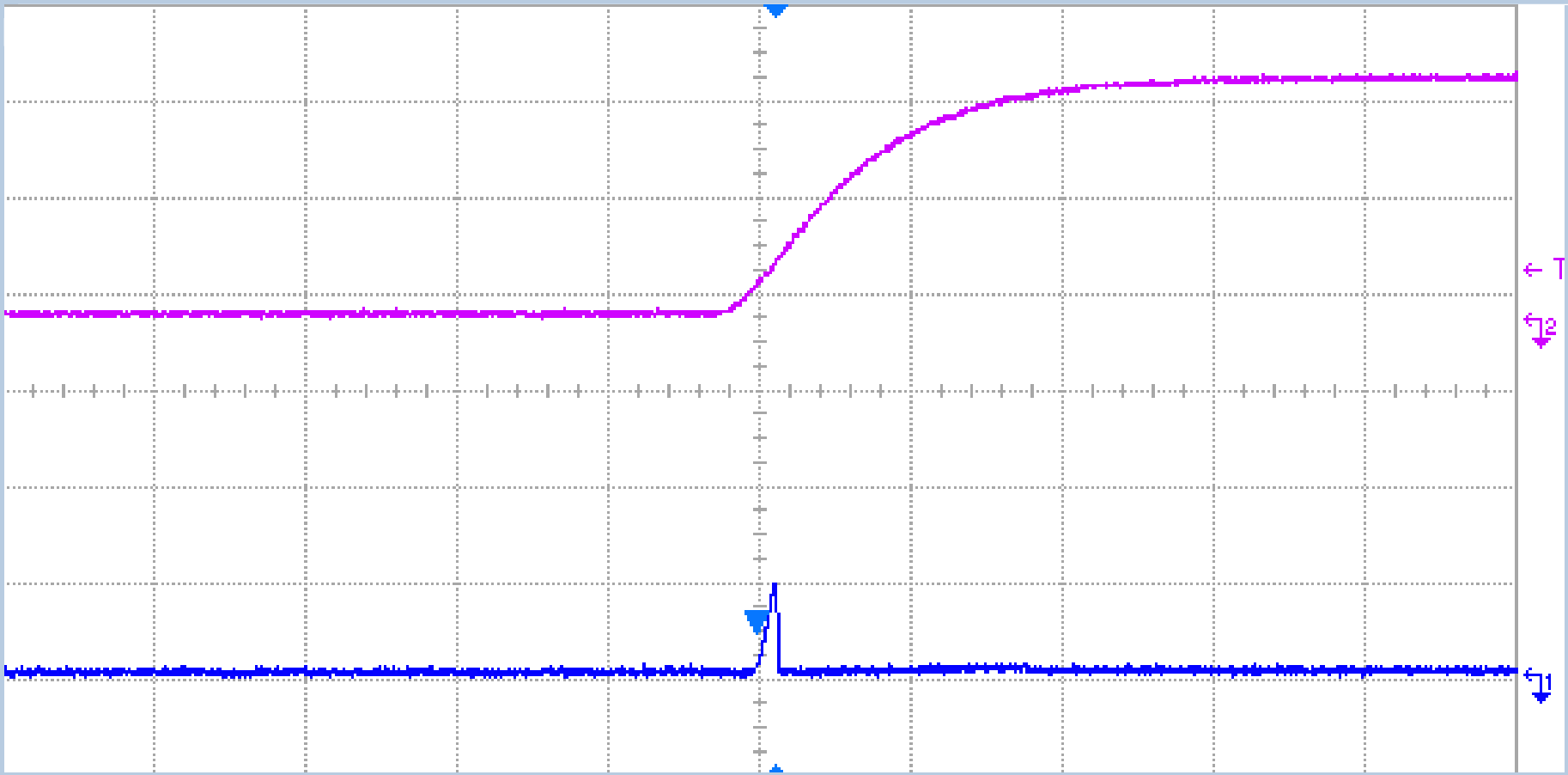
RT54SX32S with 30s cycle (SN21975 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (5A/div)

VCCA = 0V

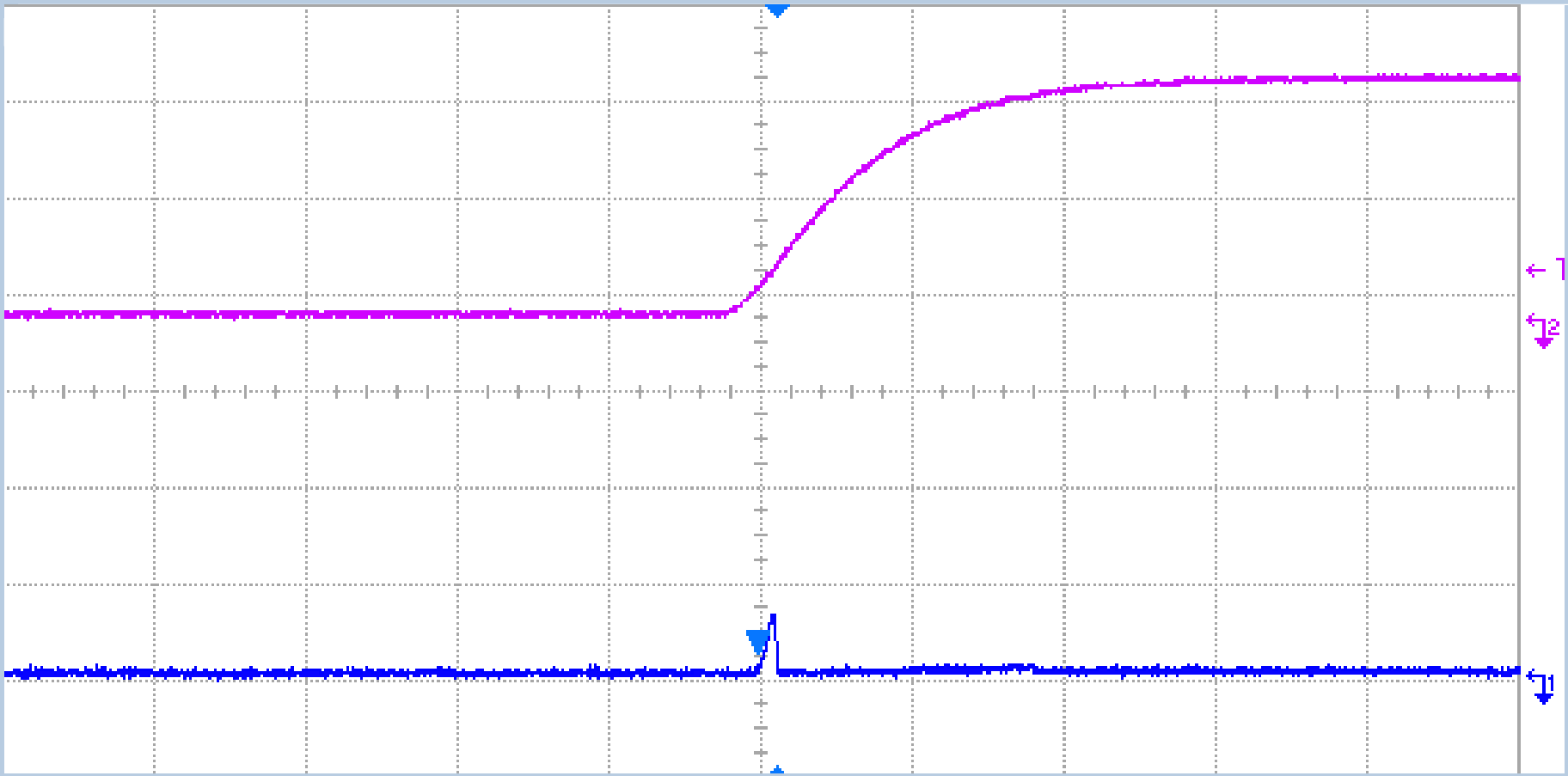
RT54SX72S with 5s cycle (SN7398 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (1A/div)

VCCA = 0V

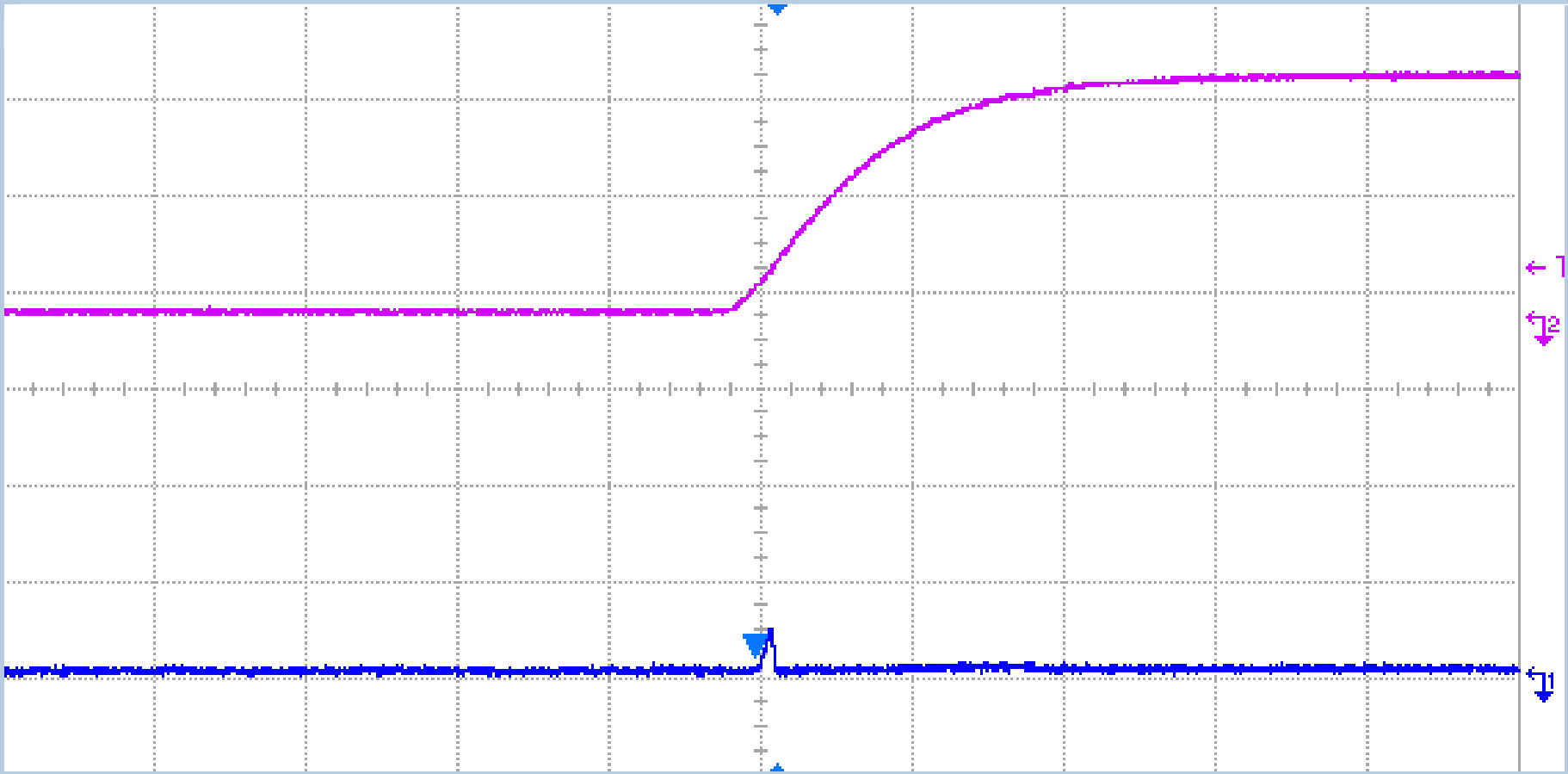
RT54SX72S with 10s cycle (SN7398 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (1A/div)

VCCA = 0V

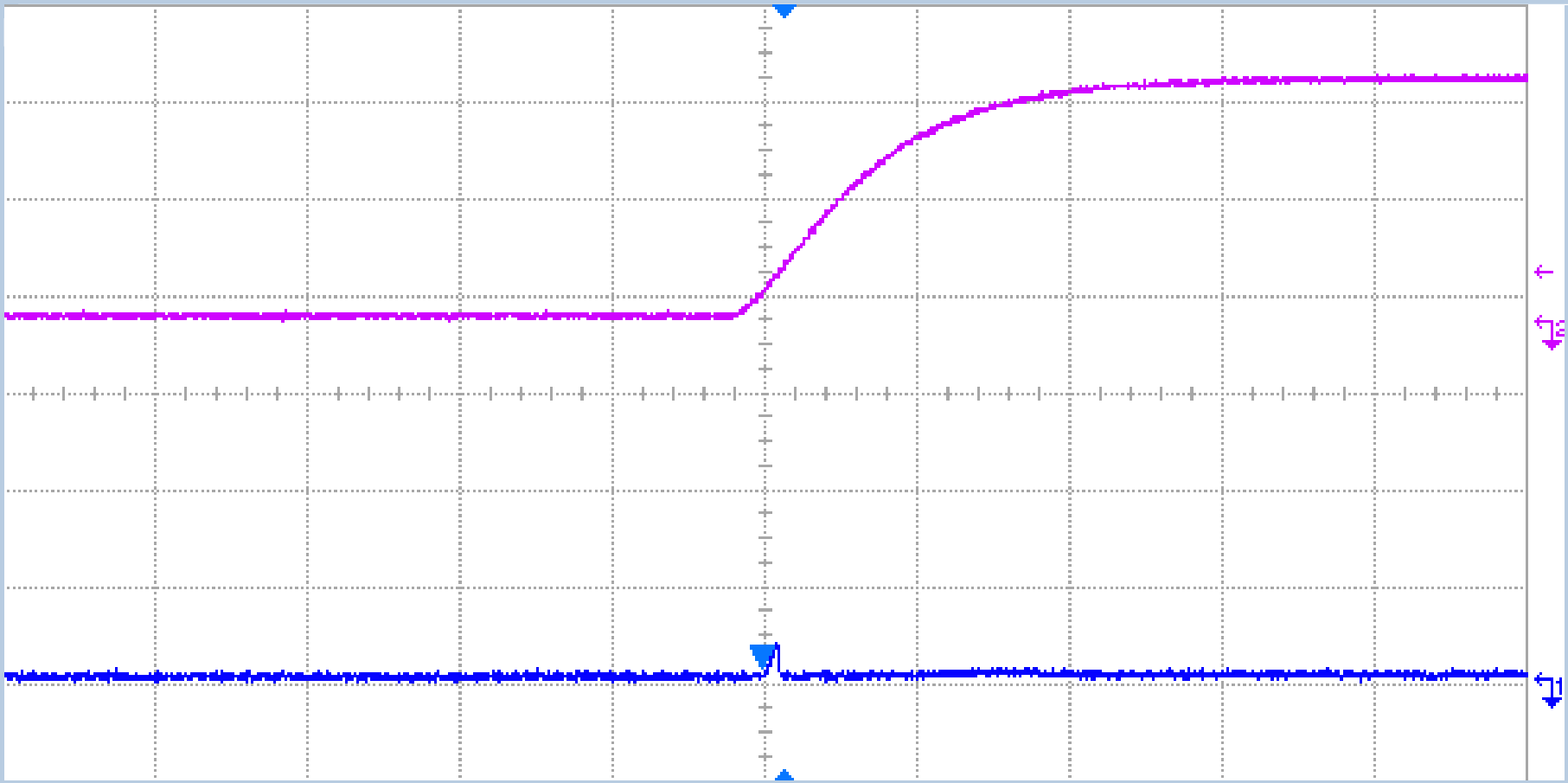
RT54SX72S with 15s cycle (SN7398 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (1A/div)

VCCA = 0V

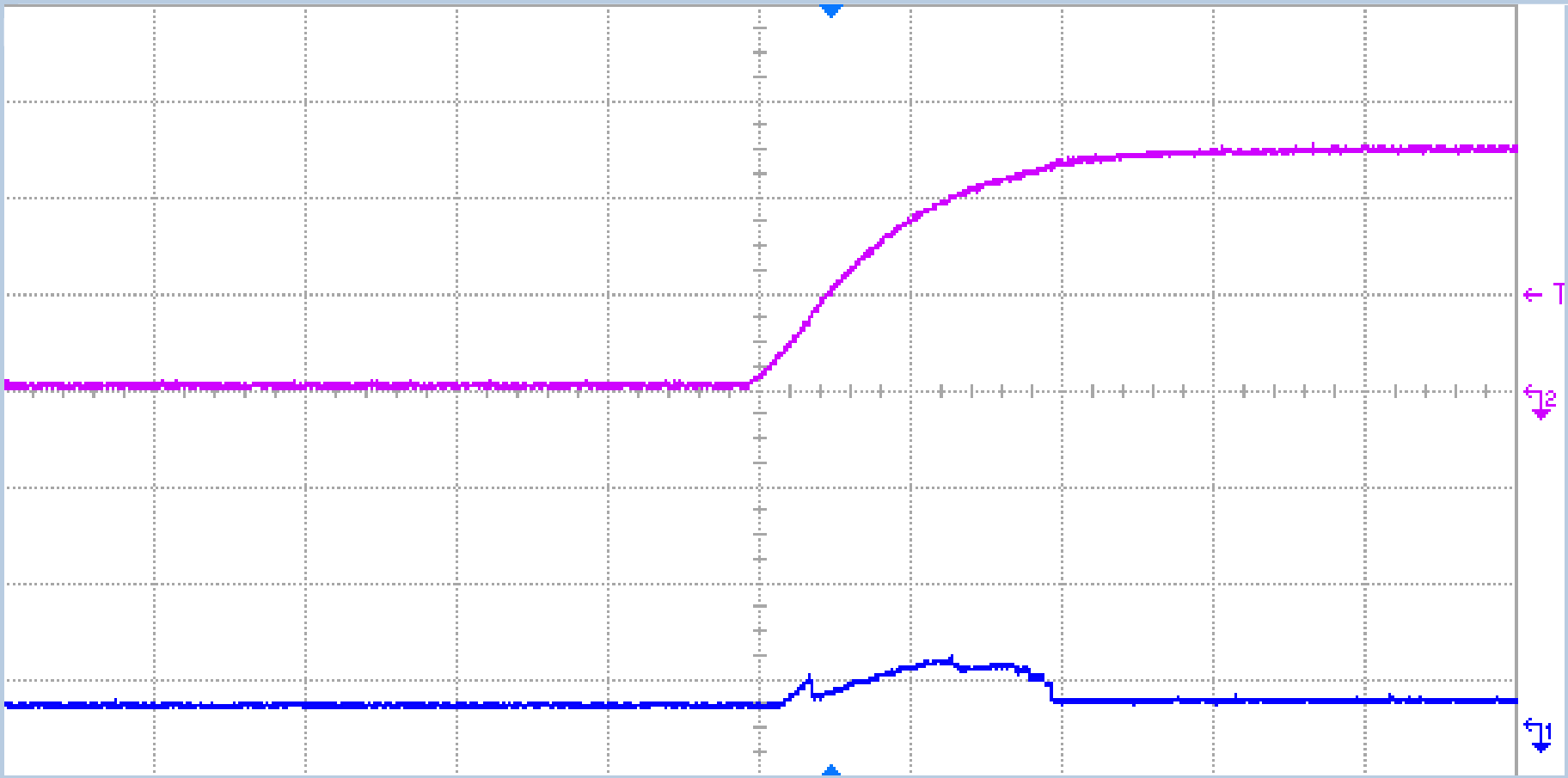
RT54SX72S with 20s cycle (SN7398 at room temp, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (1A/div)

VCCA = 0V

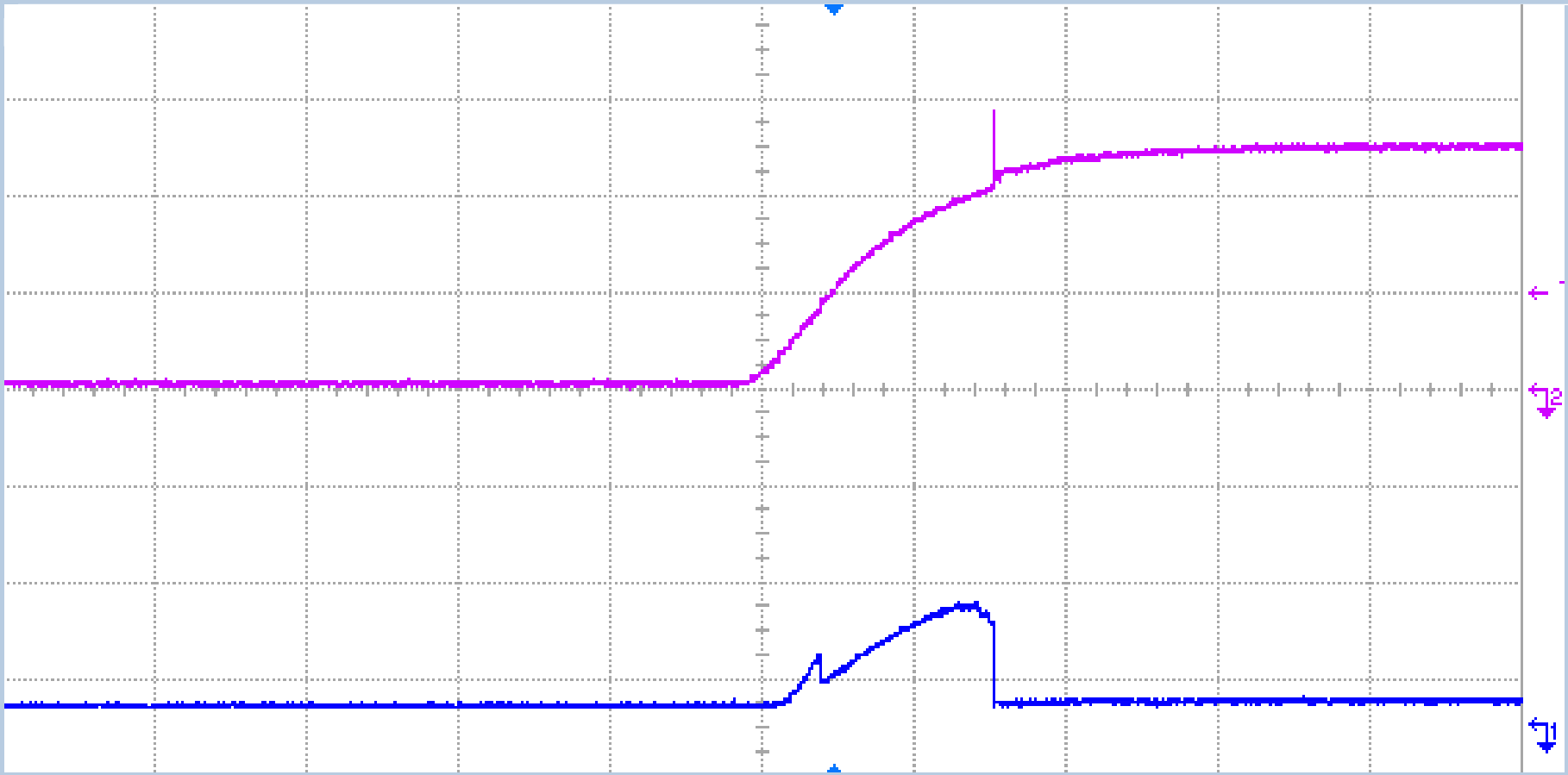
RT54SX32S at -55°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

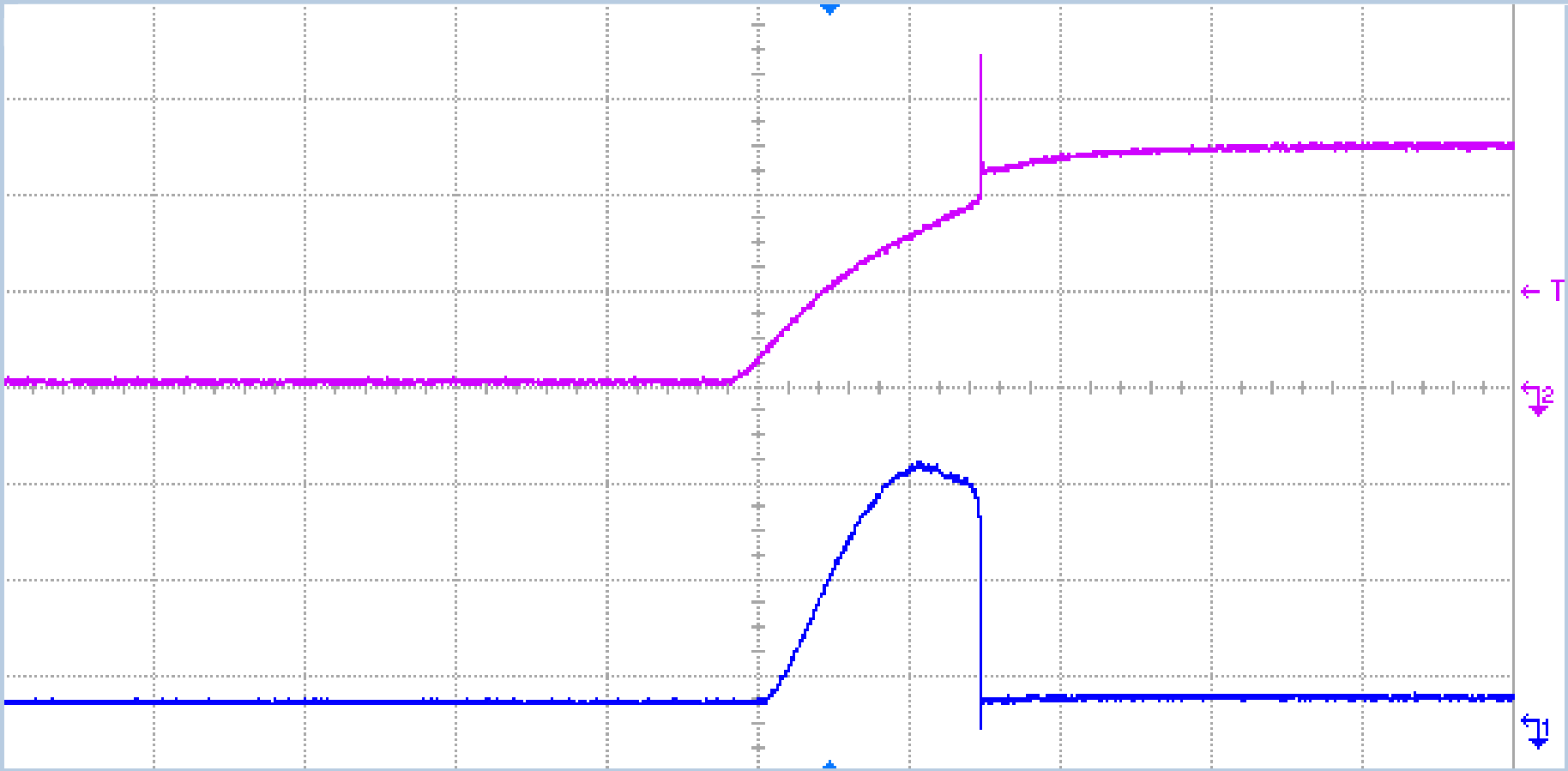
RT54SX32S at -45°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

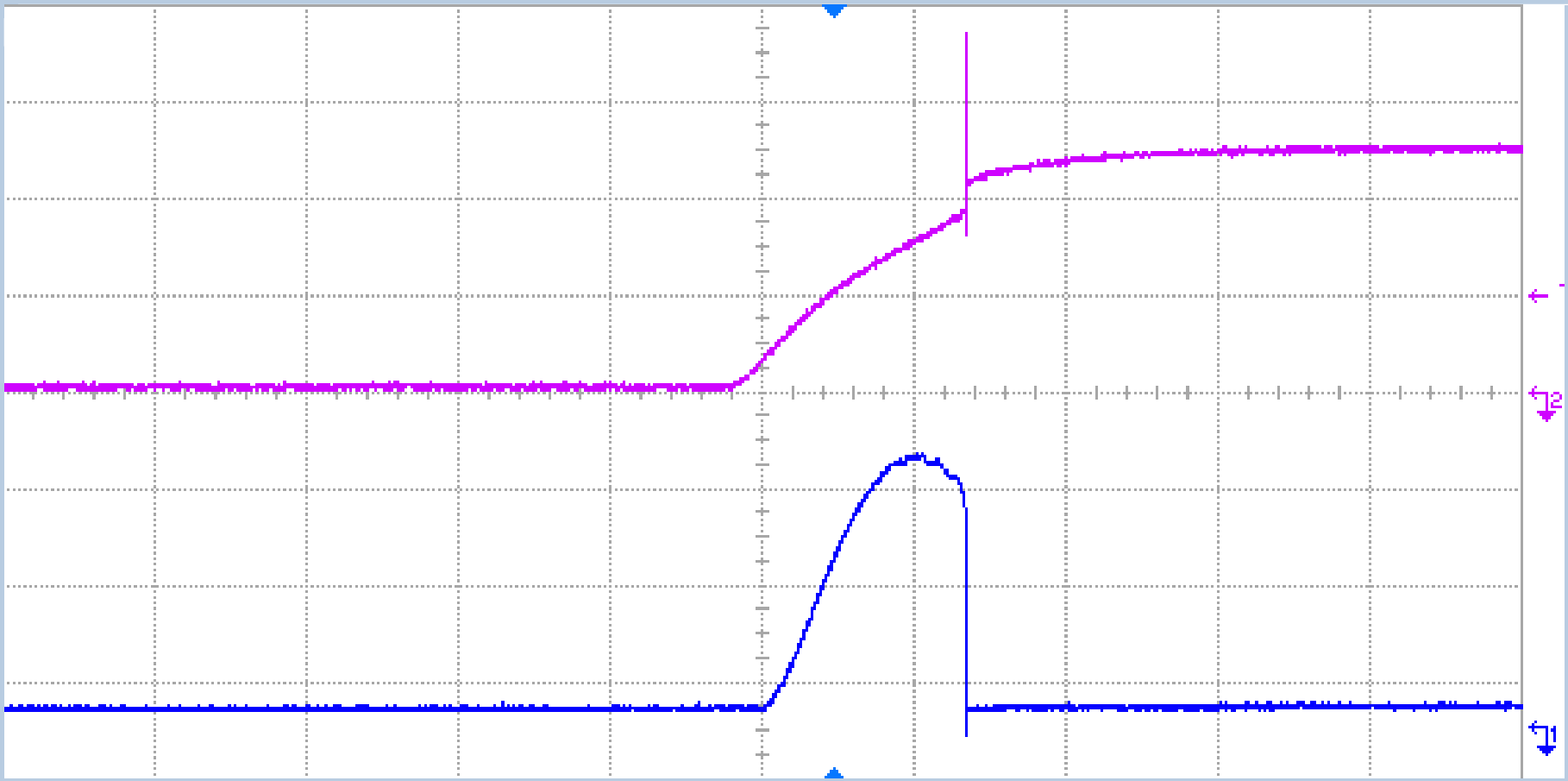
RT54SX32S at -35°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

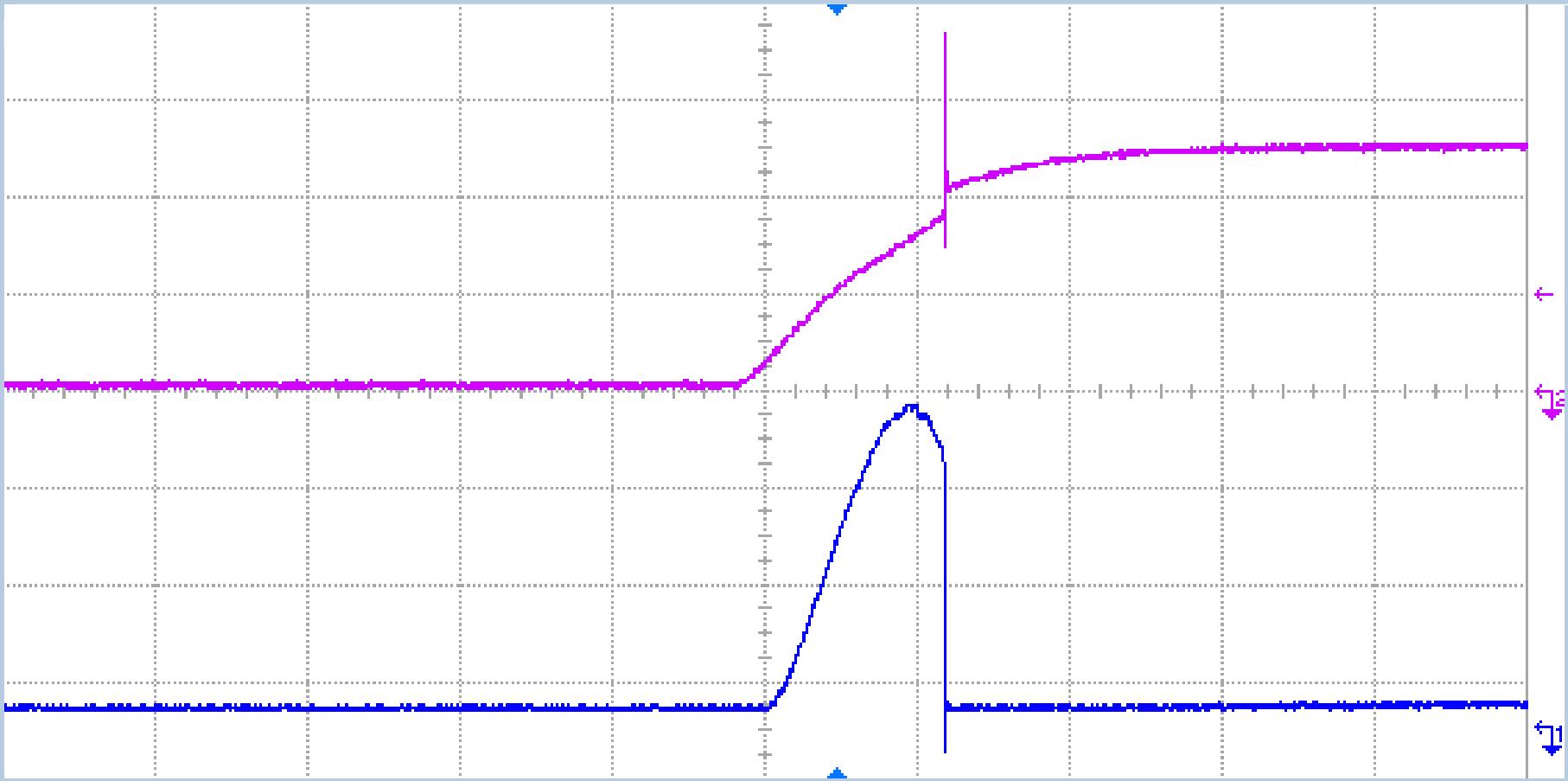
RT54SX32S at -25°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

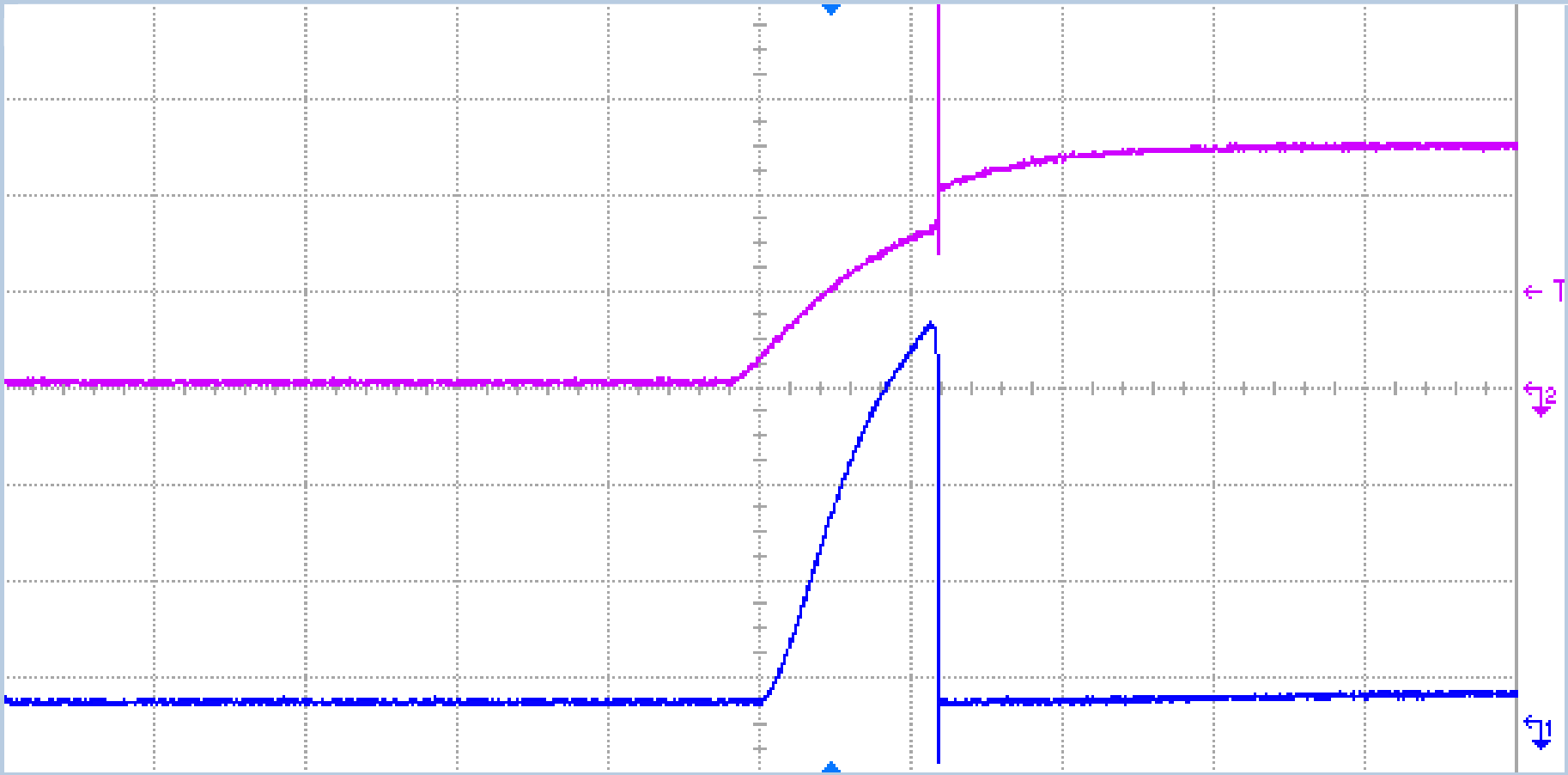
RT54SX32S at -15°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

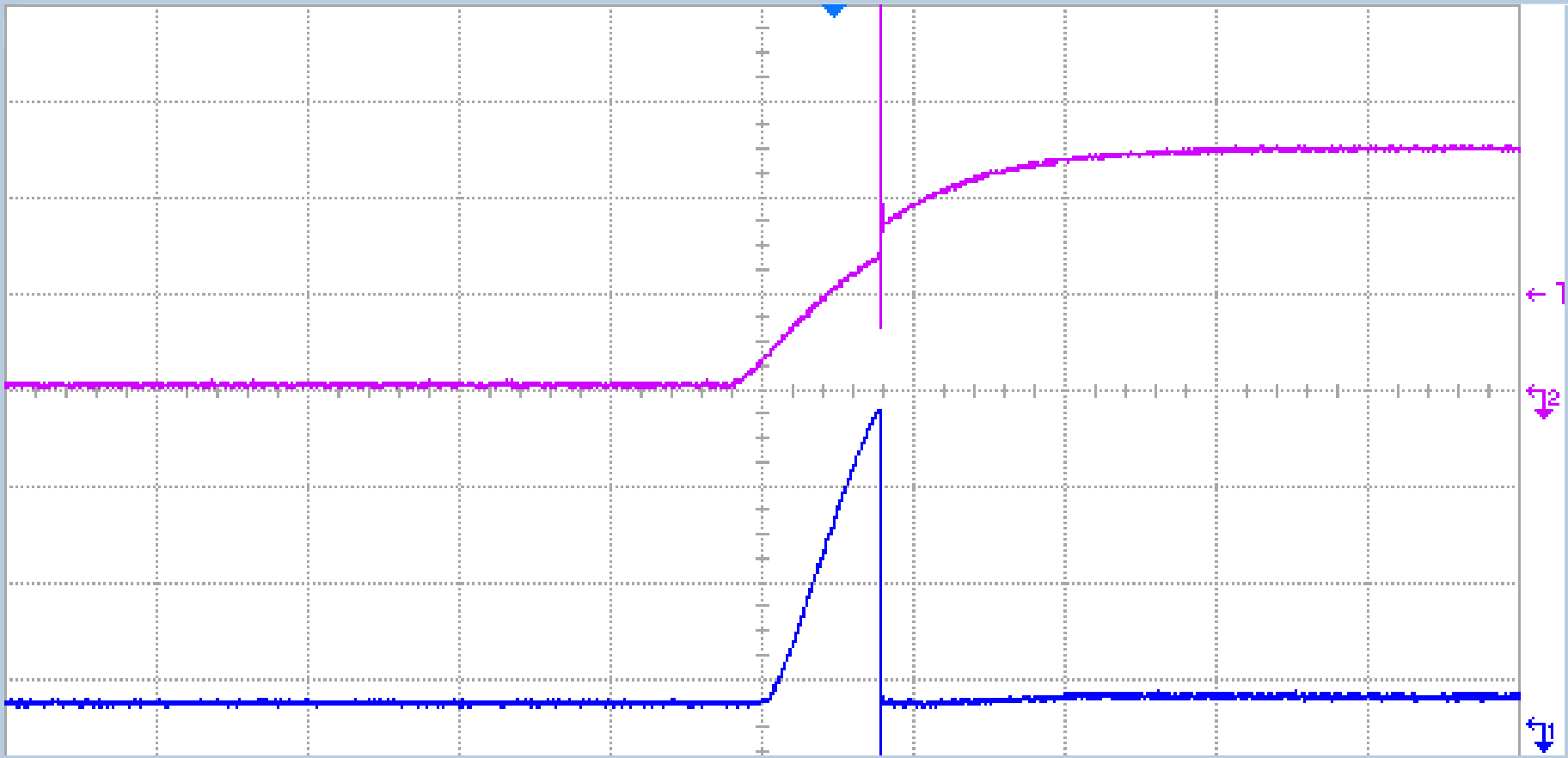
RT54SX32S at 0°C (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V

RT54SX32S at room temp (SN21975 with 5sec cycle, 5ms/div)



Purple = VCCI (2V/div), Blue = Inrush current (2A/div)

VCCA = 0V