BUR Hysteresis Circuitry to Eliminate ABM→AAM Transition (Audible Noise)

HVC

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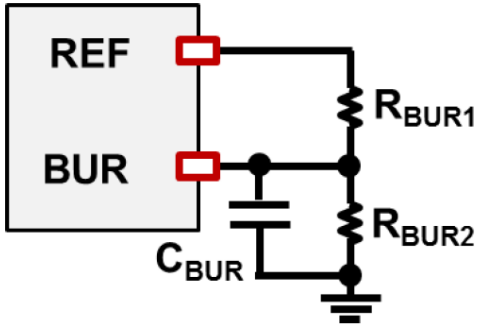
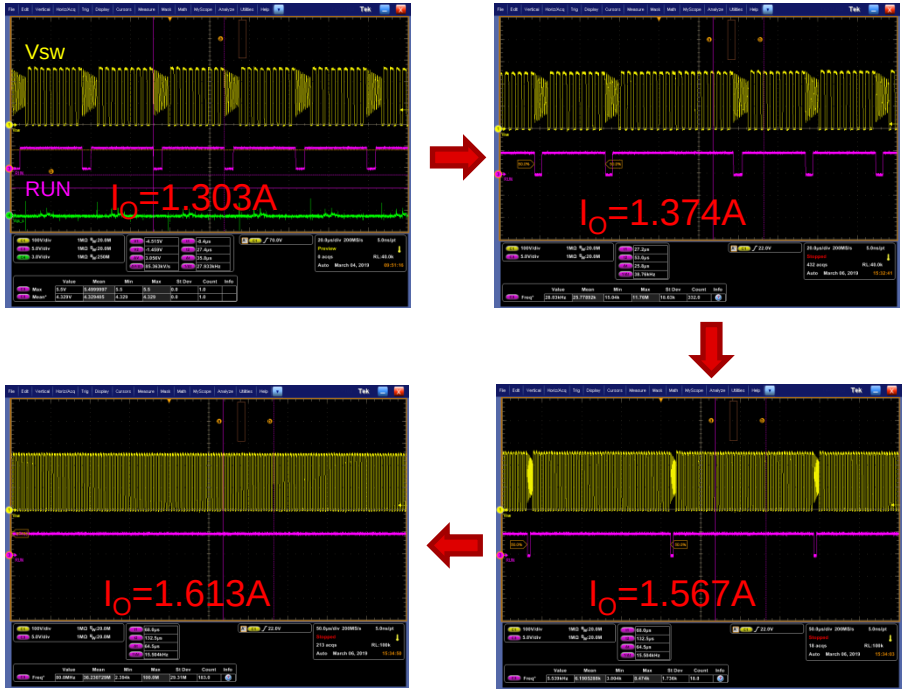
Fixed BUR-Pin Voltage(V_{BUR}): V_o=20V

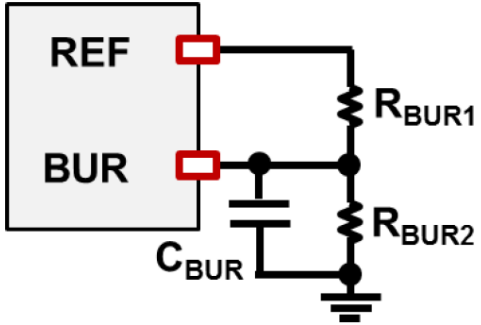


- AAM-ABM transition is 0.3A for 20V/45W output
- For the design which varnished transformer and Lower V_{BUR} are acceptable

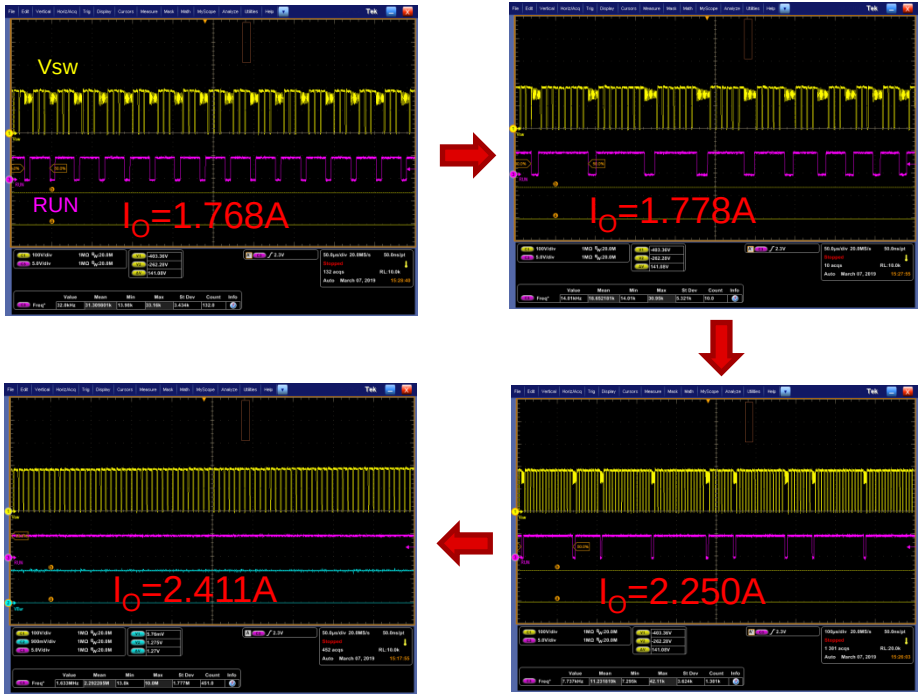
Test condition: Vin=115Vac, Vo=20V, TI 45W EVM



Fixed BUR-Pin Voltage(V_{BUR}): V_o=5V



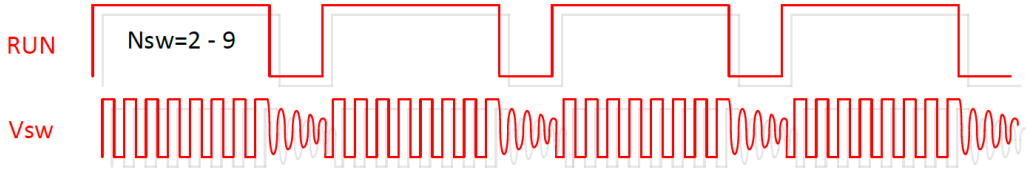
Test condition: Vin=115Vac, Vo=5V, TI 45W EVM



- Lower V_O results in lower f_{sw} operation.
- When N_{SW} adjusts under lower f_{sw} case, f_{BUR} variation is larger,
- Larger variation f_{BUR} force ABM loop performing different N_{SW} among adjacent burst packets
- ABM-AAM transition is 0.6A for 5V output

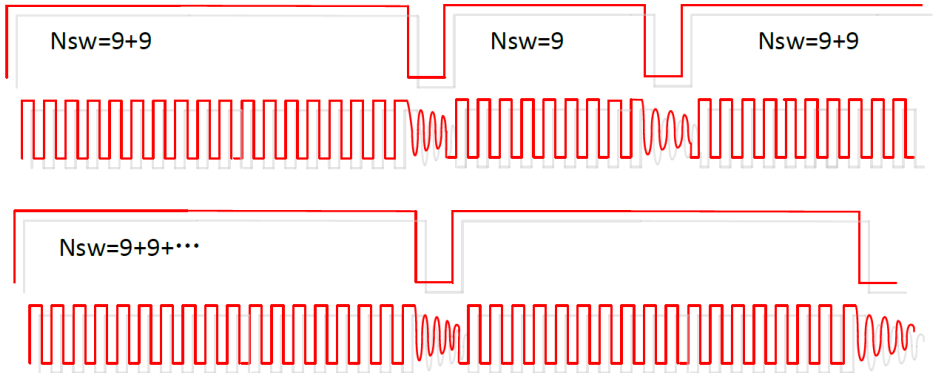
RUN Pin Voltage information

ABM:



$\overline{V_{RUN(ABM)}} = 5V * (N_{SW} T_{SW} / T_{BUR})$

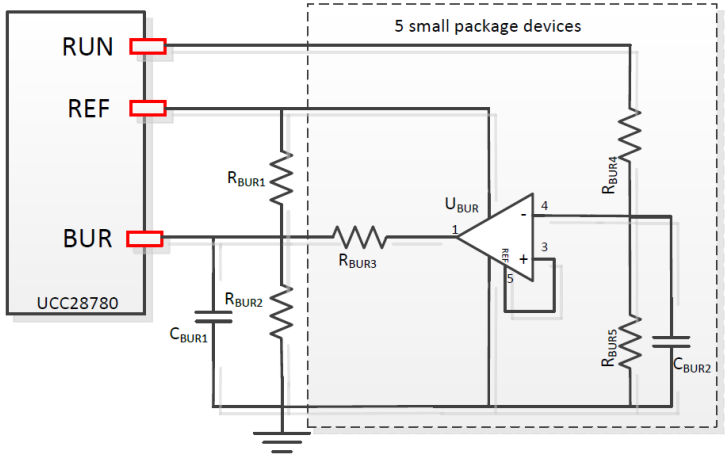
ABM-AAM Transition:



$\overline{V_{RUN(ABM)}} \sim = 5V$

More Pulses (Nsw), Higher V_{RUN}, When V_{RUN} is closer to 5V, it indicates that it's deeper AAM-ABM transition

Circuit Design Example



*U_{BUR} is a open drain output comparator which integrated reference voltage

Design guide:

V_{RUN}=5V

V_{COMP_REF}=1.242V (TLV3011)

$D_{ABM}=N_{SW}T_{SW}/T_{BUR}$

$K_{DIVIDER}=R_{BUR5}/(R_{BUR4}+R_{BUR5})$

$V_{COMP\_REF}=V_{RUN}*D_{ABM}*K_{DIVIDER}$

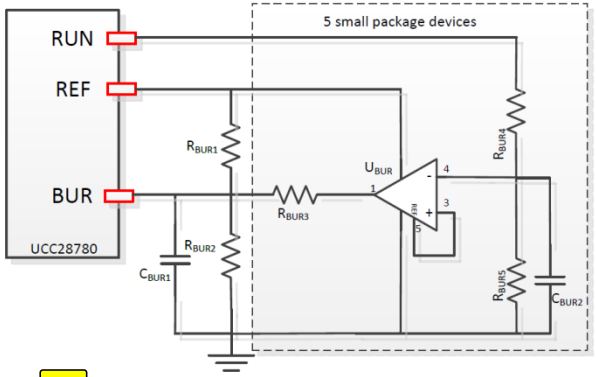
$\frac{R_{BUR4}*R_{BUR5}}{R_{BUR4}+R_{BUR5}} * C_{BUR2} \approx 20uS$

*D_{ABM} is around 0.86 ~0.95 when N_{SW} = 9 pulses

Ref	Recommend
R_{BUR1}	196k
R_{BUR2}	63.4k
C_{BUR1}	180pF
R_{BUR3}	150k
U_{BUR}	TLV3011AID
R_{BUR4}	427k
R_{BUR5}	150k
C_{BUR2}	180pF

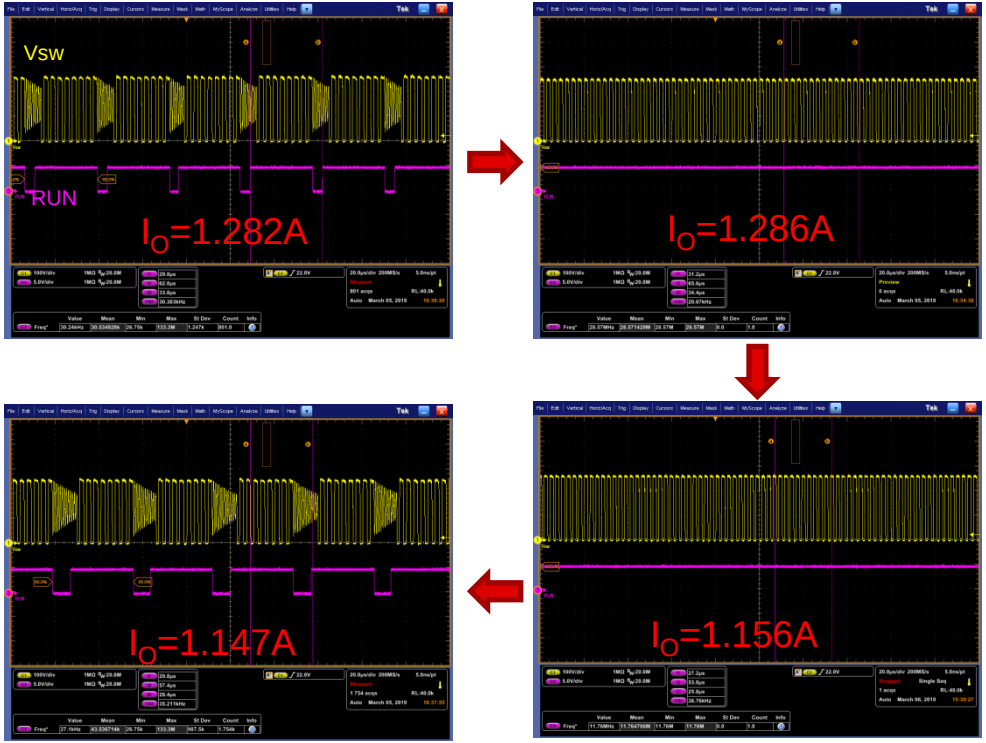
*All of R&C can use 0402 package

Verification at V_O=20V (V_{BUR}: 1.22V ↔ 0.93V)

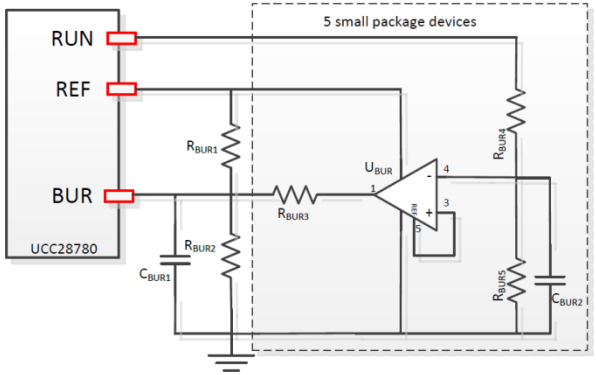


- Concept: When RUN frequency is low(More pulses in a burst package), R_{BUR3} parallel with R_{BUR2}, and lowering V_{BUR} to force controller into AAM
- For the design which varnished transformer and Lower V_{BUR} are Not acceptable

Test condition: Vin=115Vac, Vo=20V, TI 45W EVM



Verification at V_O=5 V (V_{BUR}: 1.22V ↔ 0.93V)



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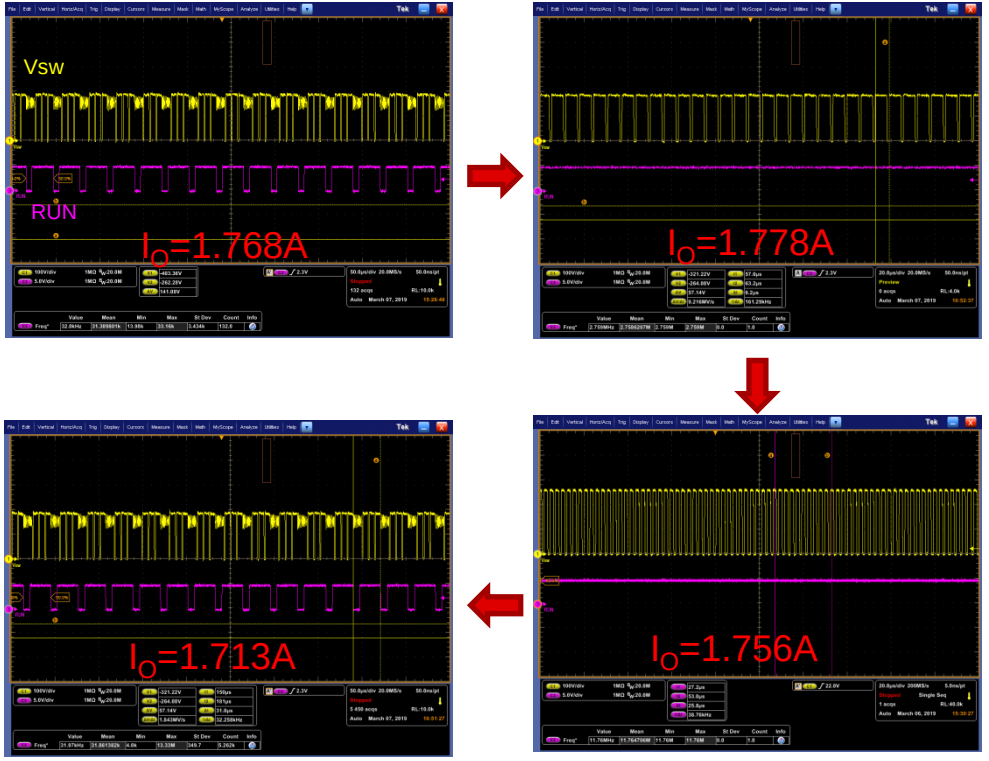


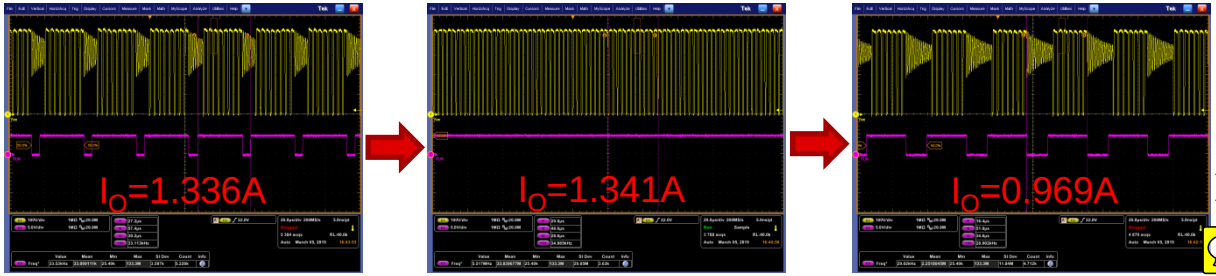
Debug tips(1)

- How to choose R_{BUR3}

R_{BUR3} set the hysteresis voltage (V_{Hys}) of V_{BUR}, Once V_{Hys} is enough for power stage jumping from ABM to AAM, The bigger , the better. Since large V_{Hys} will impact average efficiency. Special at high line.

R_{BUR1}	R_{BUR2}	V_{BUR}	R_{BUR3}	$V_{BUR\|\|RBUR3}$	V_{Hys}	I_{o_AAM}	I_{o_ABM}	I_{O_Hys}
196K	63.4K	1.219V	100k	0.826V	0.393V	1.322A	0.585A	0.737A
			150k	0.925V	0.294V	1.341A	0.969A	0.372A

* I_{o_AAM} means Load ramp up from 0A until controller entry AAM, while I_{o_ABM} means load ramp down from full load until controller entry ABM. $I_{O\_Hys}=I_{o\_AAM}-I_{o\_ABM}$



	Io	Pin(w)	Po(w)	Effi.
ABM	1.00A	21.89	20.00	91.36%
AAM	1.00A	21.91	20.00	91.28%

*ABM: Load ramp up from 0A , so Io=1A, Still in ABM
*AAM: Load ramp down from 2A, due to Io_Hys.Still in AAM

Conclusion: Such as 0.372A Io_Hys impact for average efficiency is ignorable

Condition: Vin=230Vac, Vo=20V, R_{BUR3}=150k

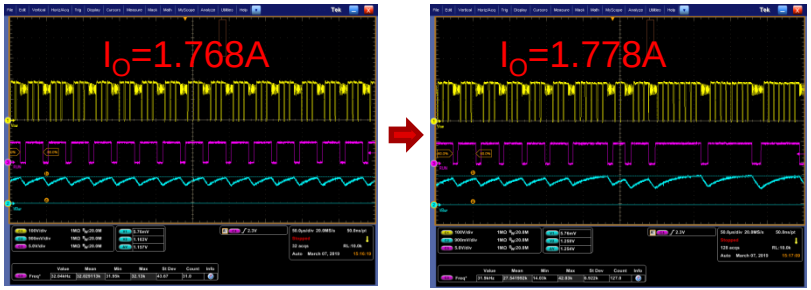
Debug tips(2)

- How to choose C_{BUR2}

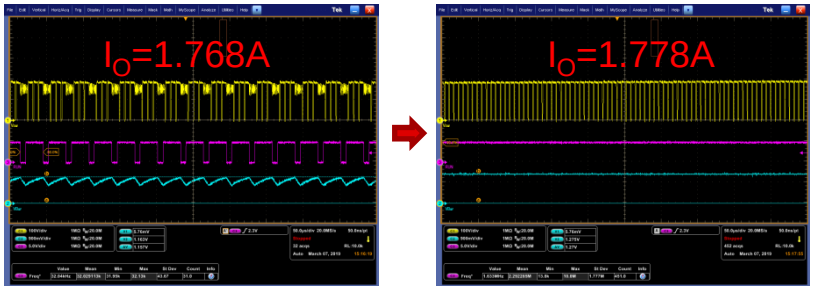
$$\frac{R_{BUR4}*R_{BUR5}}{R_{BUR4}+R_{BUR5}} *C_{BUR2} \approx 20uS$$

R_{BUR4} ,R_{BUR5} and C_{BUR2} configured as filter for RUN signal, Too strong RUN filter will delays the response of comparator U_{BUR} ,Special in low output voltage 5V when ABM-AAM transition happens. And smaller RUN filter time will in advance let ABM enter AAM than target setting.

C_{BUR2}=200pF



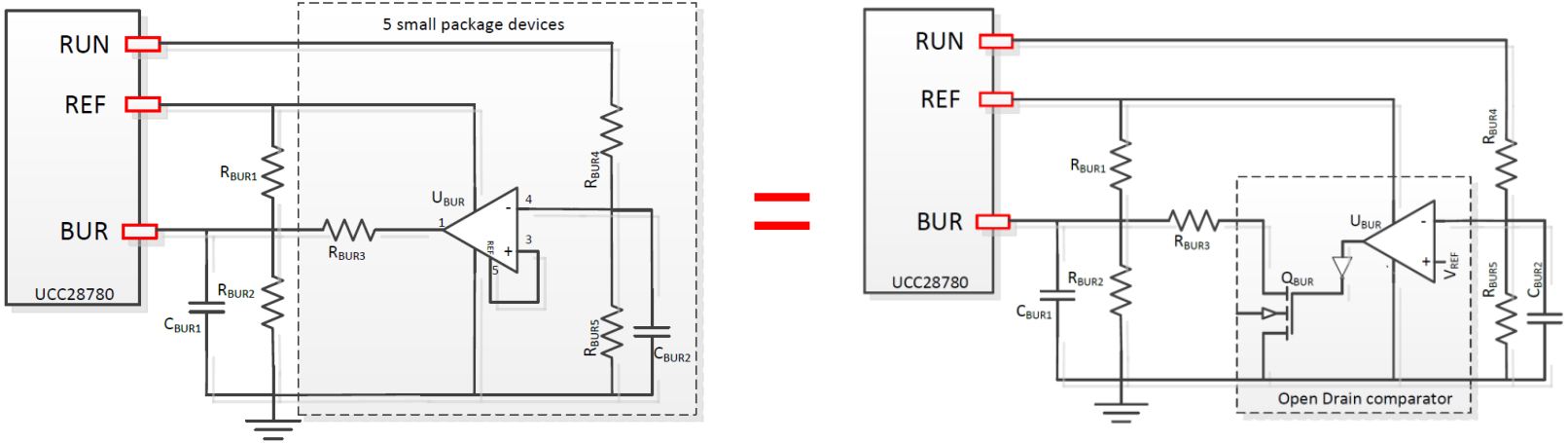
C_{BUR2}=180pF



Test condition: Vin=115Vac, Vo=5V

Note: Considering the tolerance of MLCC, C_{BUR2} value should be slightly decreased base on test results

Appendix


RUN
REF
BUR
UCC28780
5 small package devices
RBUR1
RBUR2
CBUR1
RBUR3
UBUR
RBUR4
RBUR5
CBUR2
Open Drain comparator
QBUR
VREF