

4.5V-85V Vin, 0.6A, High Efficiency Synchronous Step-down DCDC Converter with Programmable Frequency

- Sea $\frac{V_{in}}{V_{out}}$ jca60*1R)41R
- , *2= k j p q k q o K q p q p q m a j p
- , *4R - Baa $\frac{V_{in}}{V_{out}}$ Nabaraj_a Rk l p ca
- $\frac{V_{in}}{V_{out}}$ p a 31, i D e d) O e a j 1, , i H s)
O e a L k s a n l K O B A P o
- L q l o a B r a m q a j _ u l k q h p k j L B l % e d - , , q =
M q e o _ a j p q m a j p e O t a a l l k a
- O i o $\frac{V_{in}}{V_{out}}$ p a n j h O k l p o p r p e a
- = f q o p l a B r a m q a j _ u / , , G D v p k 4, , G D v
- L r a e k j A j l a P d r a o d k h b k n L r k c n i i l a
 $\frac{V_{in}}{V_{out}}$ p R k l p c a Q j a n r k l p c a H k _ g K q p L r k p a _ p k j
Q R H K % P d r a o d k h j D u o p a r a o e
- u _ l a) u) u _ l a q m a j p H e e j c
- K r a n R k l p c a L r k p a _ p k j
- K r a n P a i l a n p a r a L r k p a _ p k j
- = r e l a e j A O K L) 4 L _ g c a

Pda O P. = -, @ , *2= ouj_drkjkqo q_g_kjraparo
s e d s e a e l q p r k l p c a (n j c e c b r k i 0 * 1 R p k 4 1 R (
s d e d e j p a c n p a o j 3 1 , i d e d) o e a l K O B A P j
1 , , i l k s) o e a l K O B A P * P d a O P . = - , (k l p e c p d a
_ k j o p j p k j p e a K P %

- A) P k k l o
- A) e a (O _ k k p a n
- C L O P n _ g a n

JKPA6L ca jqi aro tknl rar & qo rar & joi u & ankni l ca jqi aro & pda _qmajpr aro & j *

Nar & j - *, 6Na & oa pk l rgap*

Nar & j - *: 6= l l & & j s r atkri o(ql & a & & j _u _qra *

Nar & j - */ 6Ql & a N- j N. _ h_qh & j r & a & l ca -- *

Nar & j - '06Ql & a ARE AKN AN & BKNI =P& J *

O P. = -, OPAN	P l a Naah	0, , ,	. = -,	4	AOKL)4

Kr ankl an & j c & aa) & pai l an & & a qj & oo k & a n & & a j k & a - %

OS	4	Nacqhpknos ϕ d ϵ c kqdpq* kjjapOS pk j atpanj hlks an ϵ q ϕ kn
Pdarih L	5	Da p ϕ o ϕ ϕ aj l ϕ dkb ϕ *A ϕ a ϕ re ϕ u kjjap ϕ aj pk CJ l ϵ *l qop a kjjap ϕ pk crkqj l hjakj L tknl rkl ankl an ϕ aj j kl ϕ ϕ a pdari hl antkri j_a*

Kr ankl an ϕ aj c braa) ϕ pai l an ϕ ra n j ca qj ϕ ao kpdars ϕ a j kpa

R ϕ	ϕ l qprkl ϕ ca n j ca	0*	41	R
R ϕ Q ϕ	Kqdp qprkl ϕ ca n j ca	, *4	. 0	R
P ϕ	Kl an ϕ aj c fqj ϕ aj ϕ ai l an ϕ ra	)0,	-. 1	

R ϕ O	Dqi j k u l k ahD l ϕ l an=J O ϕ FA A)FO), , -). , -0 ol a ϕ ϕ aj (ϕ nl ϵ o-%	).	.	gR
	d rca are a l k ah l ϕ l an=J O ϕ FA A)FO), , .) ., -0 ol a ϕ ϕ aj (ϕ nl ϵ o-%	), *	, *	gR

- (1) FA A k ϕ i ajpFAL-11 op ϕ o ϕ d p1, , RD l ϕ ks o o ϕ ai j ϕ b ϕ raj c ϕ d op j n AO k ϕ pkhl rk_aoo*
(2) FA A k ϕ i ajpFAL-13 op ϕ o ϕ d p. 1, R l ϕ ks o o ϕ ai j ϕ b ϕ raj c ϕ d op j n AO k ϕ pkhl rk_aoo*

N ϕ =	Fqj ϕ aj ϕ i ϕ ajp ϕ dari h ϕ ao ϕ j_a -%	0.	S
N ϕ	Fqj ϕ aj ϕ _oa ϕ dari h ϕ ao ϕ j_a -%	01*4	

-%O P l r k r e a o N ϕ = j N ϕ j q i a r o k j ϕ o r a b a r a j _a ϕ k a o ϕ ϕ a f q j _ ϕ aj ϕ ai l an ϕ ra o k b p d a a r e a o * N ϕ = j N ϕ r a j k p
_d n _ ϕ a n o ϕ e k b l _g c a ϕ a l l (q p k b i j u k p d a n o u o p a i h a r a h _d n _ ϕ a n o ϕ e o o q _d o p d a a o ϕ j j h u k q p k b p d a l n j ϕ a _ ϕ q ϕ
k n L %k j s d e d p d a O P. =-, ϕ i k q j p a (p d a r i h l o e a (j a t p a n j h a j r e k j i a j p h b _ ϕ k r o * P d a L k n ϕ d a p o ϵ g
p d p o k h a r a p k p d a h o j p d a r i h l k b p d a O P. =-, * d j c ϵ c p d a a o ϕ j k n k j b e q n ϕ aj k b p d a L k n _d j c a o p d a
a l l e ϕ j _u k b p d a d a p o ϵ g j p d a r a t k r a p d a _ ϕ h N ϕ = j N ϕ *

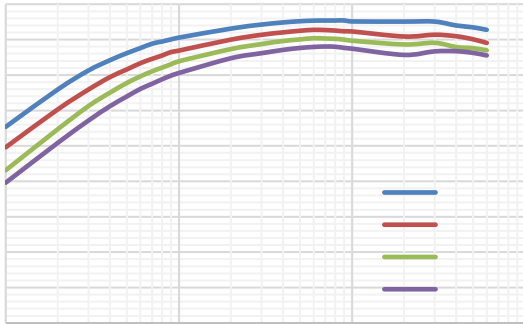
R ϕ 904R(P ϕ 9)0, z-. 1 (p u l e _h r h a ϕ ϕ a o p a q j a n . 1 *

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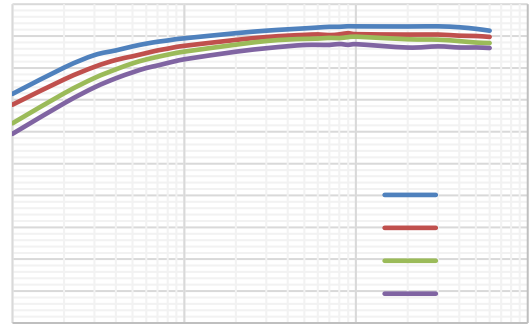
R ϕ	Kl an ϕ aj c ϵ l qprkl ϕ ca		0*	41	R
R ϕ Q ϕ R ϕ K	ϕ l q p Q ϕ R ϕ K P d r a o d k h D u o p a r a o ϕ	R ϕ n o ϵ c	0* 0, ,		R i R
ϕ o J	O d q p k s j _q r a j p b r k i R ϕ l ϵ	A J 9, (j k l k	/		θ =
ϕ	M q a o _a j p _q r a j p b r k i R ϕ l ϵ	A J b l k ϕ aj c (j k l k (j k j) o s ϕ d ϵ c (K K P) O S 91 R	-, ,		θ =

N ϕ K J D	D e d) o e a l K O B A P k j) r a o ϕ j _a	R K K P) R o s 91 R	31,	i
N ϕ K J H	H k s) o e a l K O B A P k j) r a o ϕ j _a		1, ,	i

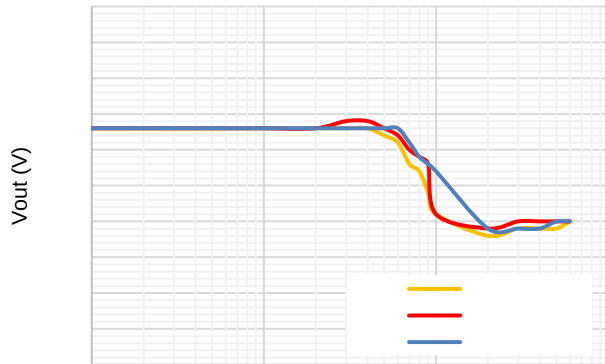
R _{NAB}	Nabara _j _a r k l p c a k b B		, *35. , *4 , *4, 4	R
R _{AJ D}	Aj la d e d p d r a o d k h		- * -	R
R _{AJ H}	Aj la l k s p d r a o d k h		- * , 1	R
E _{AJ H}	Aj la l e l q l l q l _ q m a j p	AJ 9-R	-	θ=
E _{AJ D}	Aj la l e l q l l q l _ q m a j p	AJ 9- *1R	0	q=
P _{oo}	E j p a n j h o k l p o p r p p e a		0	i o
B _{N=JCA NP}	B r a m q a j _ u n j c a q o e c N P i k a		/ , , 4 , ,	gDv
B _{OS}	O s e d e c b r a m q a j _ u	N _{NP} 91, , g - %	0. , 1 , , 2 , ,	gDv
P _{KBB I E}	I e e q i k b p e a	R _E 9- . R	. , , . 2 ,	j o
E _{E L}	H O I K O B A P I k o e e a _ q m a j p h e e	B r k i o k q n a p k n e j	, *4	=
P _{DE QL}	D e _ q l s e j c p e a	J q i a r o k b o k l p o p r p _ u _ h a o	3	_ u _ h a o
D E Q L	D e _ q l q u _ u _ l a		- . *1	
R _{KRL}	B a a _ g k r a n k l p c a s e d r a o l a _ p k r a b a r a j _ a r k l p c a	R _B *R _{NAB} n e j c R _B *R _{NAB} b l h e j c	-- , - , 1	
P _O	P d a r i h o d q p k s j p d r a o d k h	P _F n e j c D u o p a r a o e	-23 / 1	



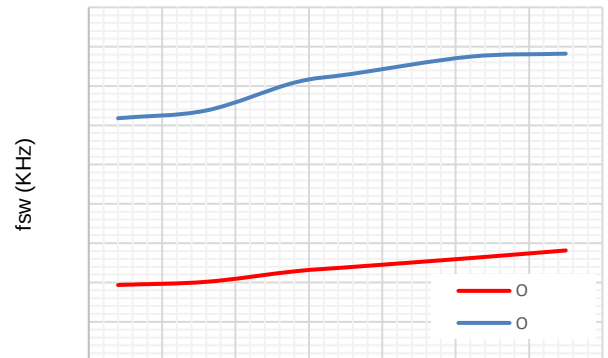
$V_{out} \text{ (V)}$
 Bēqra . * Ateaj_u ro Hk qmajp Rkqp1R%



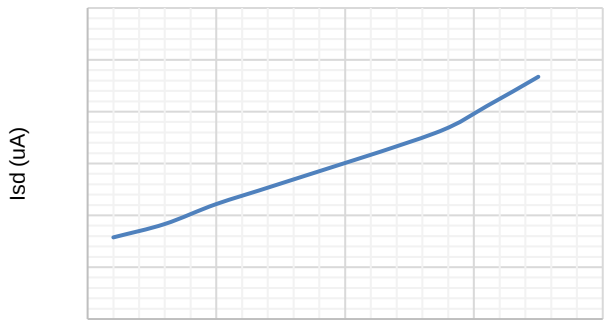
$f_{sw} \text{ (KHz)}$
 Bēqra / * Ateaj_u ro Hk qmajp Rkqp9-. R%



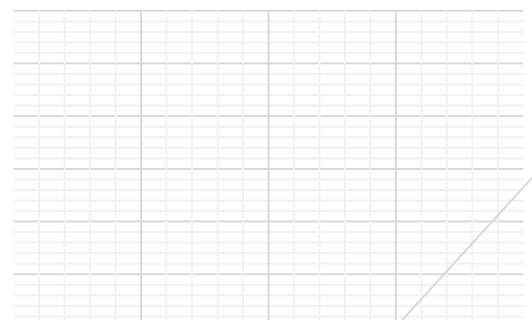
$V_{out} \text{ (V)}$
 Bēqra 0*Hk Nacqh p j Rkqp9-. R%



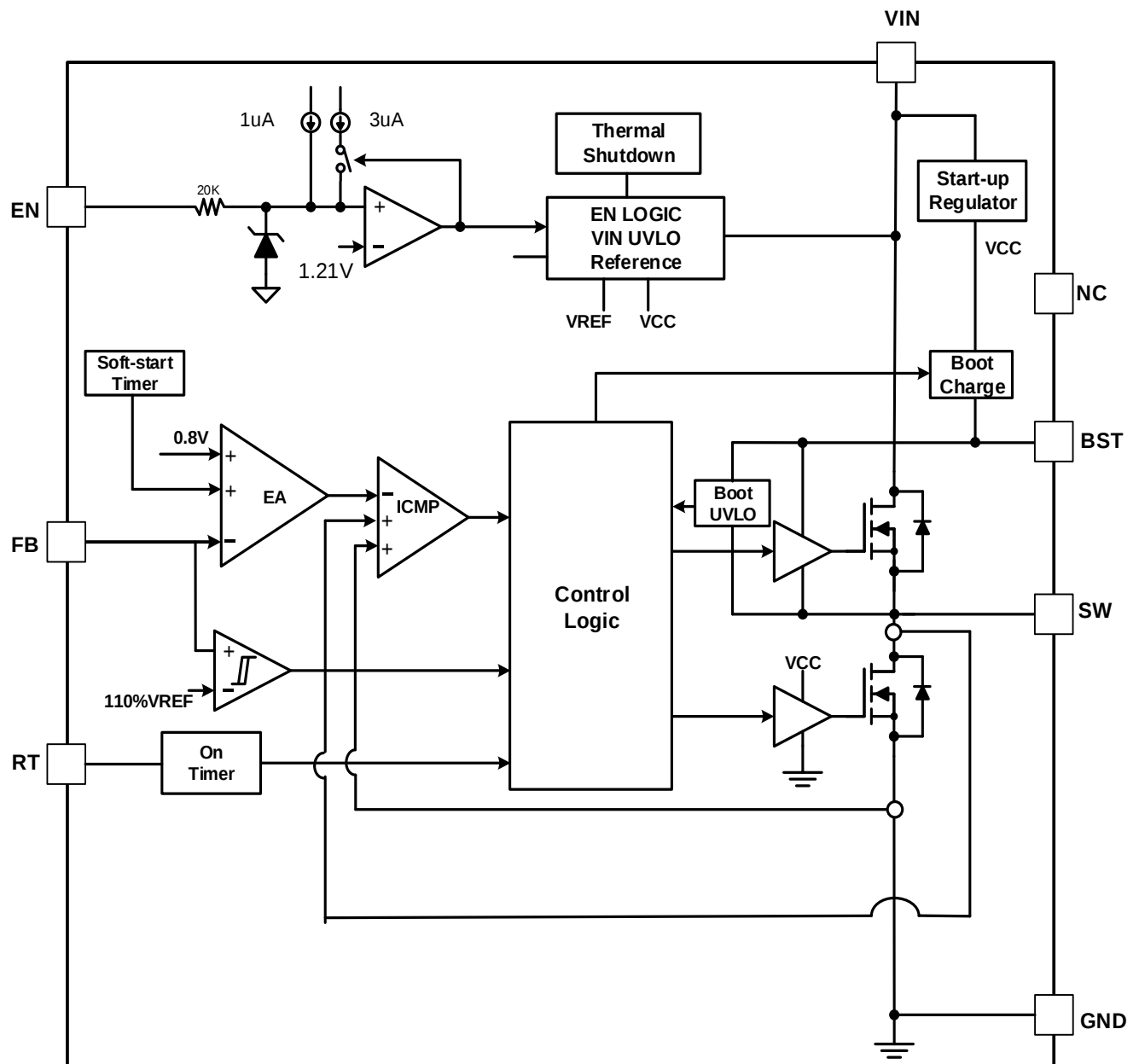
$f_{sw} \text{ (KHz)}$
 Bēqra 1 Bramqaj_u ro Pai l an p qra



$I_{sd} \text{ (uA)}$
 Bēqra 2*Odq) ks j qmajp ro Pai l an p qra

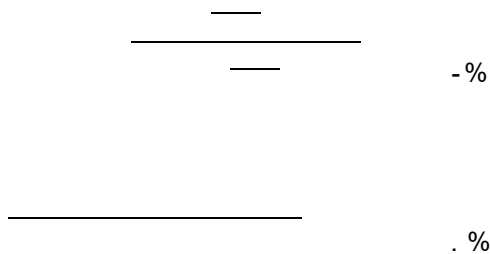


$I_{sd} \text{ (uA)}$
 Bēqra 3*Enr o Pai l an p qra



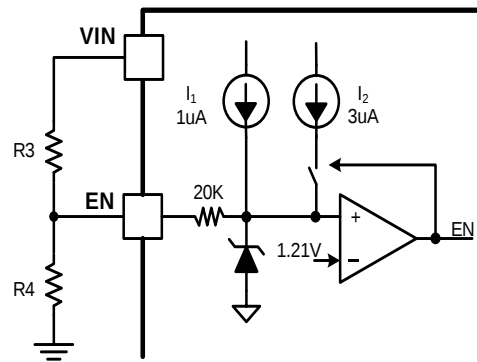
Бєqra 4*Bqj_пкј h lk_g ecn i

Pda O P. = -, @ 0*1R)41R 9l qp(, *2= kqp qp(9panj h_ki lajo pa ouj_drkjkqo q_g_kjrapans ed qd)9
31,i N okj d9d)oea j 1,,i N okj kks)oea lks anl KOBAPO



S dara

Rop r6R9 n9a pdraodkh pk aj la pda ar e a
Ropkl 6R9 b hndraodkh pk e la pda ar e a
E9- q=
E9/ q=
RAJN9- * -R
RAI B9- * 1R



Beqra 5* Ouopai QRHK u aj la e e a

Pda O P. = -, racqh p9a pda epanj htabaraj_arklp ca p, *4R s ed ±- pklan j_a kran pda kl an p9c pai l an p9ra
j rklp ca njca* Pda kqd qprklp ca e oap u raoepkn ee an brki pda kqd qpjk a pk pda B l e * p e
ra_ki i aj a pk qoa - pklan j_a kn ap9nraoepkro* Qoa Amq p9j / pk _h qh pa raoep j_a kbraoepkn ee aro*
Pk e l rka a b e aj_u p h e d p k o (h r c a n r h a r a o e p k r o r a r a _ k i i a j a * D k s a r a r (e p d a r h q a o r a p k d e d (
pda racqh p9ns e h a i k r a o q o _ a l p e l a p k j k o a h a p 9 c k q d q p r k l p c a _ _ q n _ u *

/ %

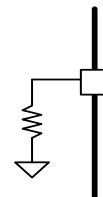
s dara

- NB PKL e pda raoepkn_kj j a _p9c pda kqd qpjk pda B l e *
- NB KP e pda raoepkn_kj j a _p9c pda B l e j k pda crkqj *

Pda O P. = -, e pacn pao j epanj hoklp op rp e q e p d p n i l o pda rabaraj_arklp ca brki vark rklp pk , *4R
rabaraj_arklp ca e Oi o* pda AJ l e e l q h a a l k s - *, 1R (os e d e c o p k l o j pda epanj hoklp op rp raoapo*
Pda oklp op rp hok raoapo qn9c odqp ks j q a p k p d a r i h k r a r t k e c *

Pda os e d e c b r a m q a j _ u k b p d a O P. = -, e o a p u l h _ e c r a o e p k n a p s a a j N P l e j j p d a c r k q j *

E j r a o e p k n o a p 9 c b r a m q a j _ u i k a (r a o e p k n l h _ a a p s a a j N P l e j p k p d a c r k q j o a p o p d a o s e d e c b r a m q a j _ u
k r a n s e a n j c a b r k i / , , G D v p k 4 , G D v * N P l e j e j k p h k s a p k a h a p h k p 9 c k n o d k r a p k p d a c r k q j * Q o a
A m q p 9 j 0 k n p d a l h k p e B e q r a - , * p k a p a r i e j a p d a r a o e p j _ a t k n o s e d e c b r a m q a j _ u j a a a *



S dara(

loos e os e d e c _ l k _ g b r a m q a j _ u

Beqra -, * O a p 9 c B r a m q a j _ u

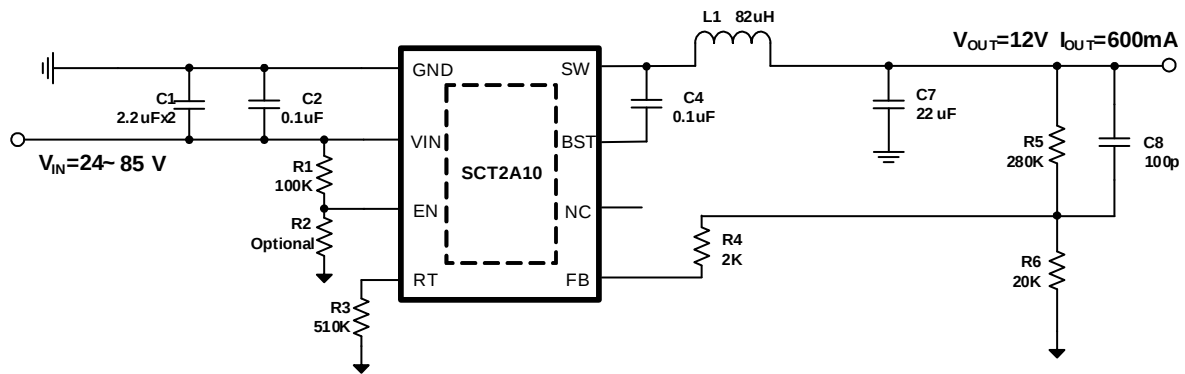
*

=j atpanj h kkppnl _l _ekn aps aaj KKPl ej j OS l ej lks arnpda tk pjc c pa neanpk ded)oea lks an
l KOBAP*Pda kkppnl _l _eknrklp ca d nca brki j epacn pa rklp ca racqh pkns daj ded)oea lks an
l KOBAP ekhb j lks)oea lks anl KOBAP ekj*

Pda ej q_pkn_qmajp ei kjekra qnjc lks)oea l KOBAP M. kj*Pda O P.=-, e lhai ajp kran _qmajp
l rkpa pkj s ed_u_ha) u)_u_ha h ejc lks)oea l KOBAPr hau _qmajp j lks)oea l KOBAPr hau _qmajp rk
ej q_pkn_qmajp nqjj ejc s u qnjc qjat la pa krark knkqd qpd n odkrp_kj ekj*

Pda O P.=-, e lhai ajp pda Kran) rklp ca Lrkpa pkj KRL _eqepu pk i ej e va kqd qprklp ca krardk kp qnjc
lk pn joajp ra_kranjc brki kqd qpb qlp_kj ekj knh edpk pn joajp*Pda krarkklp ca _ki l n pkn ej KRL
_eqep_ki l rao pda B l ej rklp ca pk pda ejpanj hrabaraj _arklp ca*S daj B rklp ca at_aa o --, kb ejpanj h
, *4R rabaraj _arklp ca(pda ded)oea l KOBAP pnj okhb pk rke kqd qprklp ca _kj p qap k ej _ra oa*S daj pda B
l ej rklp ca b h alks -, 1 kbpda, *4R rabaraj _arklp ca(pda ded)oea l KOBAP _j pnj kj c ej*

Pda O P.=-, l rkpa _pda are a brki pda i ca qnjc at_aooe a da p j lks an eo e pkj_kj ekjo*Kj_a
pda fqj _pkj pai l an ppra at_aa o -23 (pda ejpanj hpdari hoaj okno pl o lks anl KOBAPo os ed ejc*S daj pda
fqj _pkj pai l an ppra b h alks -/. (pda are a raop rps ed ejpanj hoklop rpl d oa*



ᄡᄡᄡ ᄡᄡᄡᄡ ᄡᄡ	04R Jkri h . 0R ᄡᄡ 41R
K ᄡᄡ ᄡᄡᄡᄡ ᄡᄡ	- . R
I t ᄡᄡ ᄡᄡ ᄡᄡᄡᄡ ᄡᄡᄡᄡ	2, , i =
Os ᄡᄡ ᄡᄡᄡᄡ ᄡᄡᄡᄡ	1, , GDv
K ᄡᄡ ᄡᄡᄡᄡ ᄡᄡᄡᄡ ᄡᄡᄡᄡ ᄡᄡᄡᄡ	1, i R
Pn j ᄡᄡᄡᄡ Naol k j ᄡᄡ 2, i = ᄡᄡ 10, i = ᄡᄡ ᄡᄡᄡ	Rk ᄡᄡᄡ 0, , i R

Pda kqđ qprkđ ca đ oap u j atpanj hraođkn đ e an
 N1 j N2 đ pul e h l l e pđj o_dai pđ*
 Na_ki i aj a N2 raođp j_a đ -, : G * Qoa amđ pđj
 1 pđ _ h_qh pđ N1*

**Table 1. R_s, R_c Value for Common Output Voltage
 (Room Temperature)**

1/ R	2/ *1 G	. , G
1 R	-, 1 G	. , G
-. R	. 4, G	. , G
. 0 R	14, G	. , G

— 1%

s dara6

- R_{NAB} đ pda baa _g ra baa j _a r kđ ca (pul e h
 , *4R

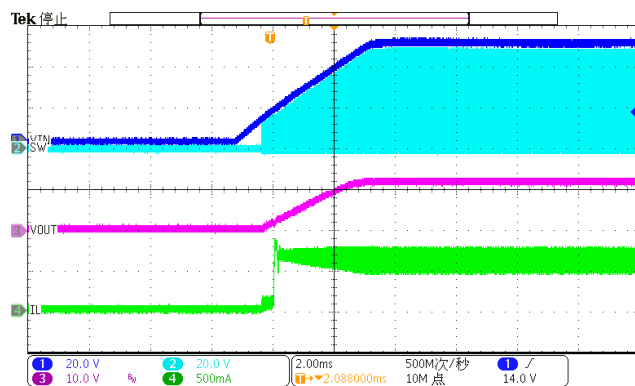
= j atpanj hr kđ ca đ e an j a s krg kb N- bki pda đ l qđđk AJ l đ

-
- R_{KOP} e pda k qd qpr klp ca
 - R_B e pda e l qpr klp ca

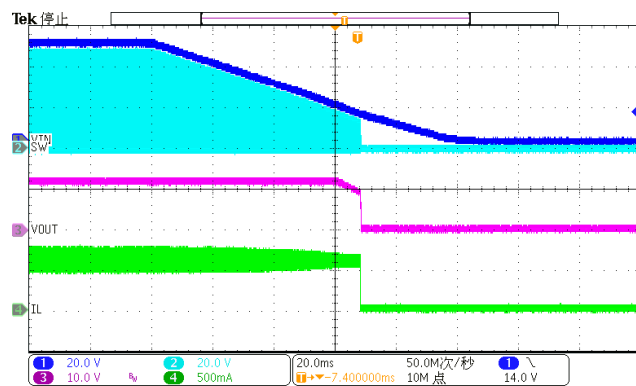
O e _a pda e q _p k n _q m a j p n e l h a e _n a o a s e d pda e l qpr klp ca (ok pda i t e q i e l qpr klp ca e l l h e p k j e
 l s u o q o a p k _ h _q h p a pda i e e q i e q _p j _a n a m q e a * Q o a A m q p k j 5 p k _ h _q h p a pda e q _p j _a r h q a *

Pda rklp ca n pjc kbpda ejl qp_l _ekni qop a cra panpd j pda i t e qi ejl qprklp ca*=j pda_l _ekni qop
lok dra nel la _qmajpn pjc cra panpd j pda i t e qi ejl qp _qmajpn el la* Pda NI O _qmajp ej pda ejl qp
_l _ekn

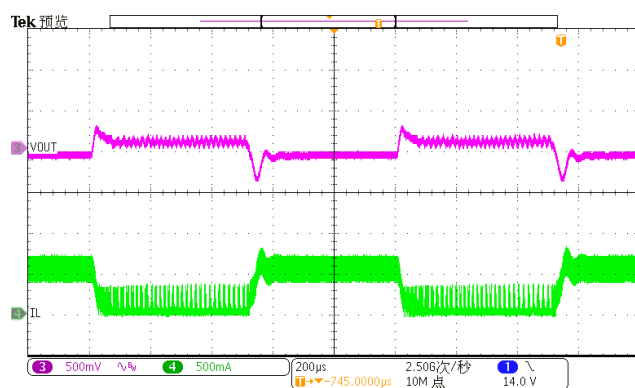
Rq 904R(Rk qp9 - . R(qj hoo kpdars oa j kpa



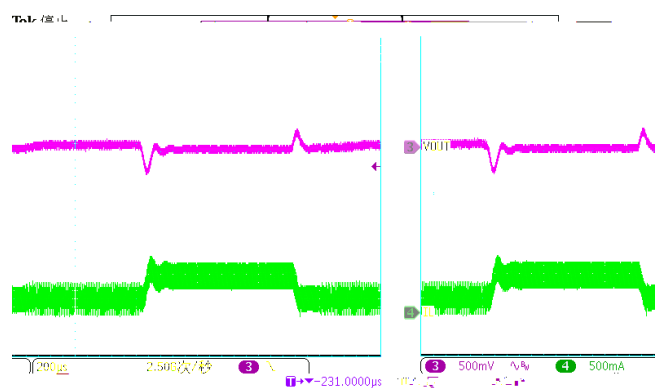
Bqra - . *Lks anql



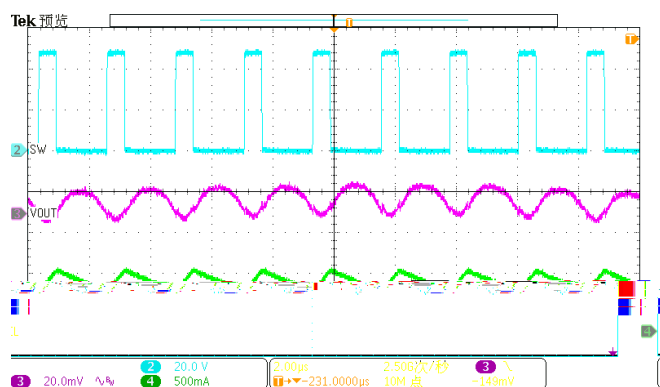
Bqra - / *Lks an ks j



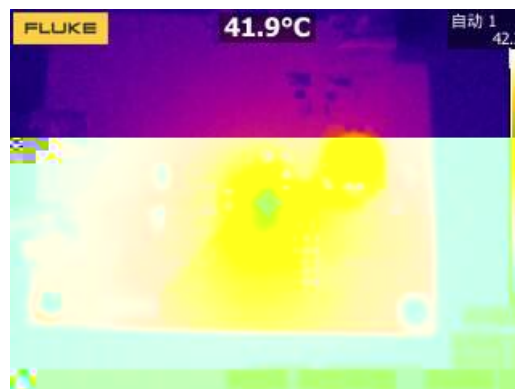
Bqra -0*Hk Pn joajp , *2=), *10=(, *1=+qo%



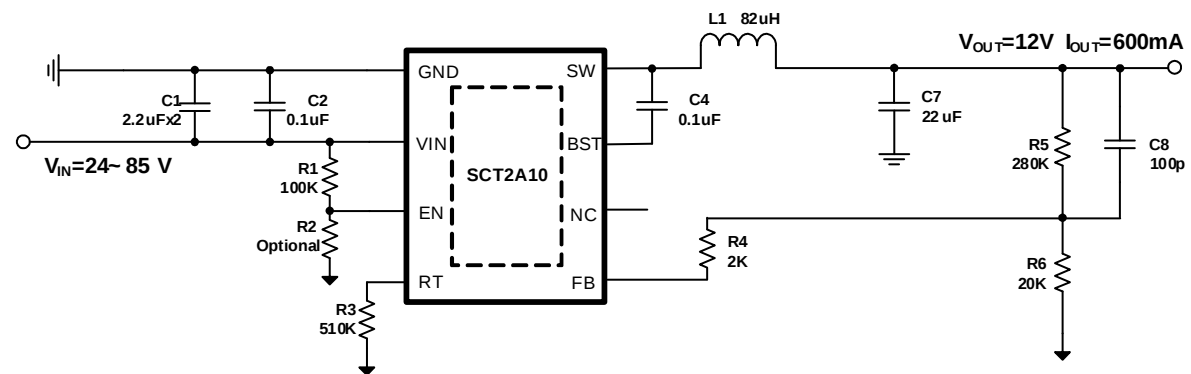
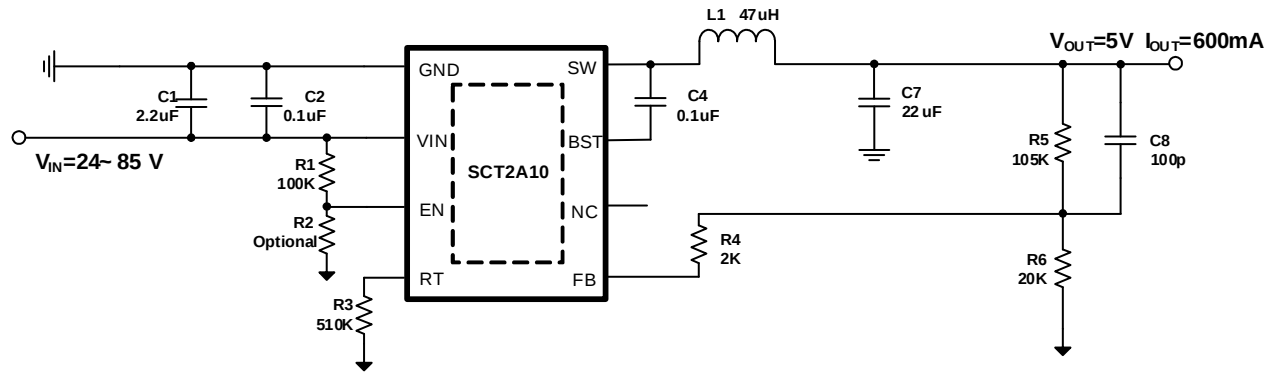
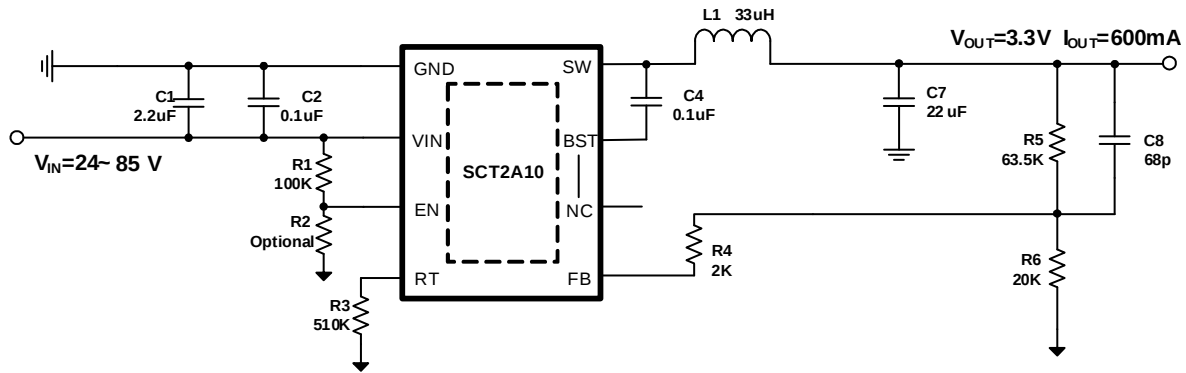
Bqra -1*Hk Pn joajp , *1=), *01=(, *1=+qo%



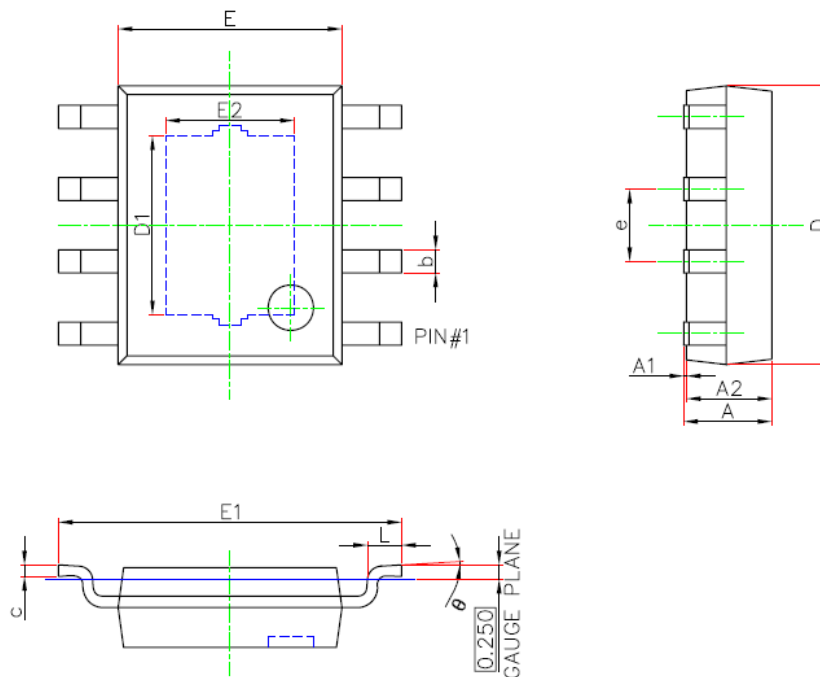
Bqra -2*OS j RkqpNl l a



Bqra -3*Pdani h 04REJ (- . Rkqp(, *2=



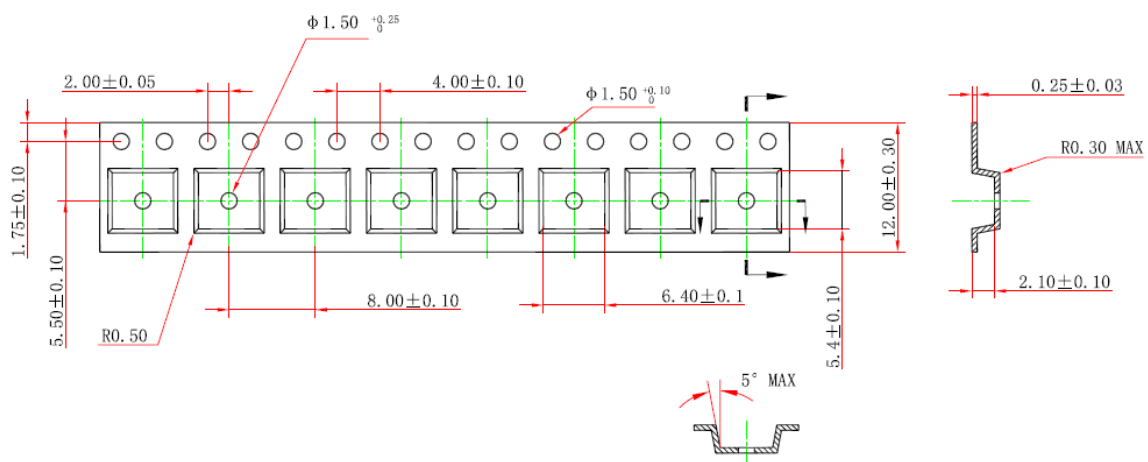
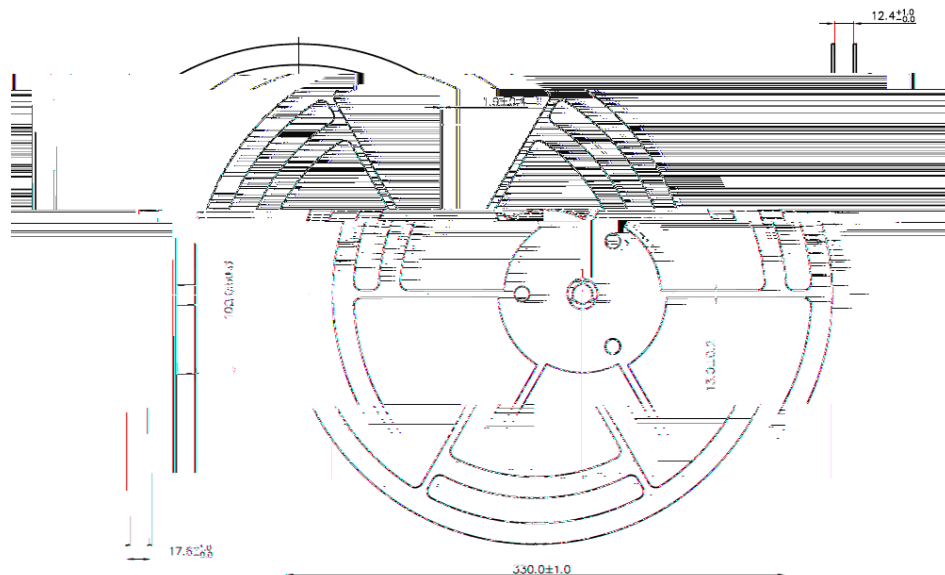
Lrkl anL hukp@_ne hknO P.= -, o op la j abe ajpkl an p j *Pda m j ad d g j Zq p j w op b p p d c k no a
_qma j p knrk l p cao na a ou p k e pan _p s e d op u e q _p j _a j l n o e _ l _ e j _a p k cajan p a j k e a j
acn al an k n i j _a *Bkn apanrao q p o (k k k s p daoa c q e a h e a o o f G k y g V



AOKL4LL 51t -/, %L _g ca Kqđja é ajokjo

Qui kh	é ajokjo g l é aparo		é ajokjo g E dao	
	l é *	l t *	l é *	l t *
=	-/, ,	-*3, ,	, *1-	, *, 23
=-	, *, ,	, *, ,	, *, ,	, *, 0
=.	-*/1, ,	-*11, ,	, *1/	, *, 2-
	, *//, ,	, *1-, ,	, * -/	, *, ,
	, *-3, ,	, *1, ,	, *3	, *, -
	0*3, ,	1*- , ,	, *-41	, *, -
-	/ *1, ,	/ *1, ,	, *- ,	, *, -4
A	/ *4, ,	0* , ,	, *-1, ,	, *-13
A-	1*4, ,	2* , ,	, *. 4	, *, 00
A	. *-2, ,	. */2, ,	, *41	, *, 5/
a	-*3, 0 %		, *, 1, 0 %	
H	, *0, ,	-*3, ,	, *, -2	, *, 1,
θ	, ,	4	, ,	4

- nséclrlkloa pk ai a FA A l _g cakqđja l K). , r nepkj *
- nsécljpkpko _la*
- =théa n é ajokjo ra g i é aparo*
- Pdari hl od th aokhara kj pda k n *
- é ajokjokbatlkoa l kj kpk kbl _g ca kjkpé _h ai kh thod*
- kjp _L k n b ne pkj bkni é é qi okhani ogsa pk an j _ao aps aaj pda l é o*



Pda ɛtkri ɛk j ɛ pɔ k_qi ajpɔ oq fa_pɛk_d jcas ɛɔkɔpjkɛa* Qoaro oɔkqh s m jp j cɔ n jpa pda pɔn
 l ɛ pɛ pɛ pɛ pɛ hLrk l aru nɛ dɔ na jkp ɛ lɛ ca q l k j s daj ɛ pɛ n pɛ c Oɛ k j k j p a p a _ d j k l k c u O P % r k q _ p ɛ j k j u
 l l l e _ p k j * O P s ɛ h j k p o o q i a j u l a c h r a o l k j o e ɛ p u t k n j u o e l l l e _ p k j o *