Revision 2 02/07/2004
Included in rectified voltage calculations the fact that:
Diode detection law below threshold voltage is linear
Diode detection law over threshold voltage is quadratic
Minimum detected power is taken as 0,5% of meter full scale
L1/R2 ratio at minimum frequecy decreased from >8 to ~5 to improve
accuracy at high side of the useful band

Revision 3 17/07/2004
Included software MINIRK.EXE in spreadsheet
Improved DC rectified voltages calculations lines 25 & 26

Revision 4 25/07/2004
Added wattmeter full scale value
Modified minimum detected power calculation

Revision 5 January 2006
Added schottky diode max voltage
and check of value in fwd & ref voltages. Becomes black on red if value too high

Revision 6 July 15, 2006
Check of value of diode maximum reverse peak voltage (Vr). Becomes black on red if value too low
Diode Vr max shall be less than Vrms x ~4
Removed check in fwd & ref dc voltages

Revision 6a July 17, 2006
Added test measurements results table & graph
Page now in "landscape"
Added calculations for R1 with 2 paralleded resistors

Revision 7a November 11, 2006
Added information about GND strap

Revision 7b April 21, 2007
Added Check flux with MINIRK12 to avoid toroid saturation at lowest frequency
If toroid is saturated, increase size or redduce voltage

Revision 8 September 09, 2008
Modified bridge drawing to have phase compensation antenna side
Added maximum flux in toroid verification sheet
Added selection list for toroids and automatic Al choice
Added AMIDON material 43 and 61 toroids data

Revision 8a September 10, 2008
Added material "2" in calculations and documentation

Revision 8b September 19, 2008
Included coupling factor 99% for L1
added nota about ratio L1/R2 and accuracy

Revision 8c September 30, 2008
added warning colors for ratio L1/R2 less than 7 and 5

Revision 8d November 06, 2008
Modified safety ratio warning for detectors PIV. Is now 2.88 x RMS voltage

Revision 8e November 23, 2010
Correction of not very clear texts: in C1 manual calculation
and in R2 dissipated power

Revision 9 November 25, 2010
Added TRUE MEASURED value of toroid AL

Revision 10 December 07, 2010
Added minimum supply voltage of automatic SWR board

Revision 10a March 30, 2011
Added nota about TRUE measured AL

Revision 10b April 21, 2011
Corrected data source in results graph which was not working

Revision 10c February 1st, 2012
Added nota line 30, to decrease output voltages if necessary.

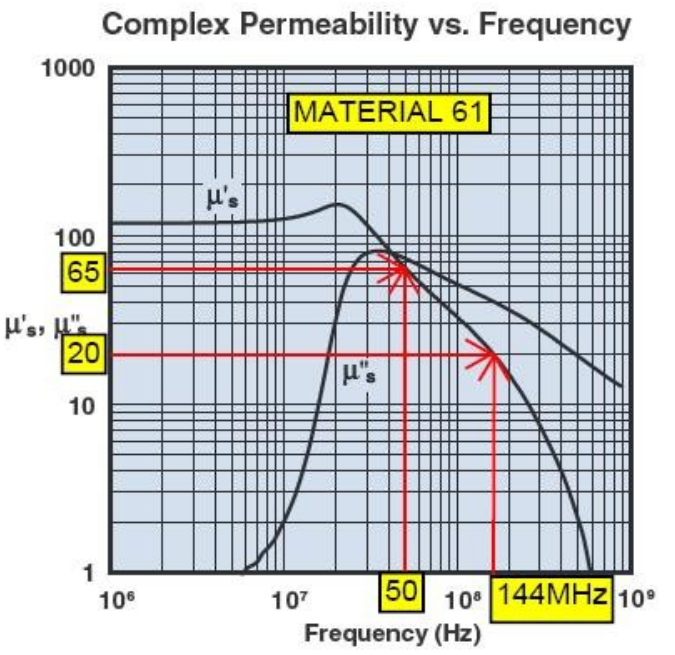
Revision 10d August 15, 2012
Deleted the material 2, red toroids, as NOT ADAPTED TO WIDEBAND DESIG

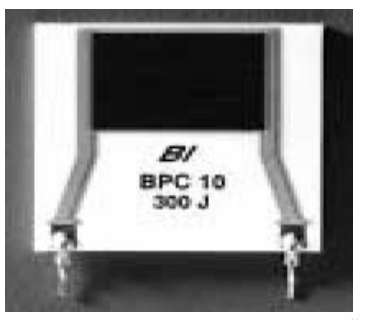
Revision 11 January 07, 2014
Modified Cell C18: C2 (pF) adjustable (+ fixed value if necessary)
Formula was: =(2*2^0.5*C8*C16*C3)/C12-C16
Formula now: =(2*C8*C16*C3)/C12-C16
Replaced R1 by variable resistor VR1

NOTA: For monoband 50 MHz with material 61, divide NOMINAL Al of toroid by 2
NOTA: For monoband 144 MHz with material 61, divide NOMINAL Al of toroid by 6

Revision 12 December 11, 2014
Modified Cell C7: Becomes "True AL" if true AL entered in cell F7
Added nota about max nb of turns.
R2 BPC10 (10 Watts) serie standard values see picture
Added wire CSA calculation
Added notas lines 31 to 33

Revision 13 January 2020
Modified formula in cells C26 & C27 which was: =SI(C20>C25;((C25+(C20-C25)*PI()/2));C20)





STANDARD RESISTANCE VALUES (OHMS)							
Value	1	2	5	10	20	50	100
Code	1R0	2R0	5R0	100	200	500	101

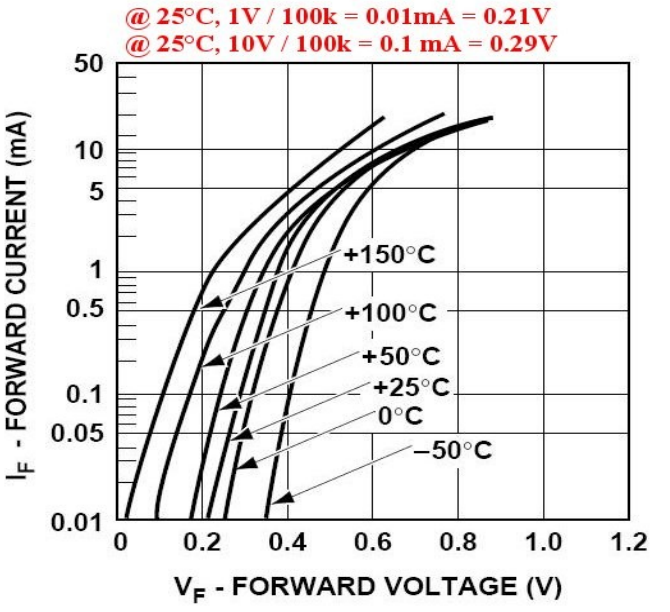
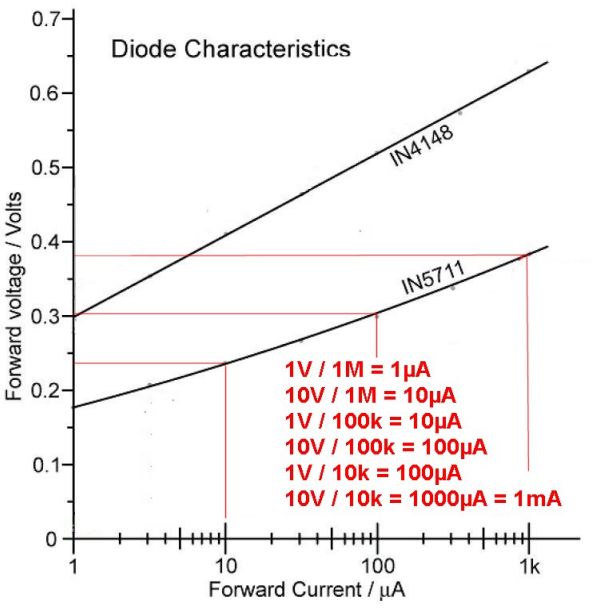


Figure 5. I-V Curve Showing Typical Temperature Variation for 5082-2800 or 1N5711 Schottky Diodes.



COLOR CODE: INPUTS= BLUE / OUTPUTS= RED / INFORMATION= BLACK

F1FRV January 2020 REVISION 13

(See revisions page)

LINE IMPEDANCE Z (Ohms)	50		
Maximum power (Watts)	2 500		
PERMANENT Maximum SWR to be accepted by the bridge	10,0		
Reference of toroid	FT 140-43	>>	CLICK HERE FOR TOROID FLUX VERIFICATION PAGE !!
Nominal average AL of toroid (nH / turn²)	885,0	>>	True measured AL :
Nb TOTAL of turns (N) INSIDE toroid (2 x N/2) (MUST be EVEN !!)	8		True measured AL MUST stay BLANK if no measured AL
L1 (uH) with coupling factor 0.99	56,074		If Total Nb of turns > 10, Decrease R2 value.
Bridge Minimum Frequency of use (MHz)	1,800		This, to minimize L1 parasitic capacitances.
L1 / R2 ratio at minimum freq. (shall be >7 for <1% accuracy)	126,8	>>	L1/R2 = 3 power error ~5% and phase ~18°
R2 (Ohms) Shall be NON INDUCTIVE !!!	5,00		L1/R2 = 7 power error ~1% and phase ~8°
Max current in R2 and toroid winding (Amps)	3,95	>>	Wire MIN CSA (sq mm) 1,32
Bridge coupling design dB	47,09		Wire MIN Dia. (mm) 1,30
R2 dissipated power (Watts) at maximum permanent power	7,81	>>	AT MAXIMUM SWR : 10,00
C1 (pF)	0,96	>>	2 x RG 402 pF/m
Max Voltage on C1 (Volts peak/peak)	1 581		2 x 2000 V MAX 95,1
C2 (pF) adjustable (+ C2a fixed value if necessary)	152,6		C1 MANUAL CALCULATION
VR1 variable resistor to adjust with Ohmmeter at value	146 025		2 lengths of (mm) 20,0
FWD Volts on R2 (Volts rms)	5,44		C1 (pF) incl. strays 0,96
REF Voltage on R2 (Volts rms)	4,45		See Picture at page bottom
FWD Apparent Power (Watts)	7 562,50		
REF Apparent Power (Watts)	5 062,50		
Detection diode maximum Peak Inverse Voltage (Volts)	70	>>	1N4148 (PIV 100V, FV 0.3V @ 1uA) High FV.
Detection diode Treshold Forward Voltage (Volts)	0,180	>>	See diode manufacturer data for values.
Estimated forward rectified voltage (DC Volts)	7,611		Quadratic detection below threshold voltage
Estimated reflected rectified voltage (DC Volts)	6,213		Linear detection over threshold voltage (FV).
With output power (Watts)	2 500		1N5711 (PIV 70V, FV 0.18V @ 1uA) is the best.
Minimum reflected detected power will be (Watts)	0,364	>>	with directivity measured in tests

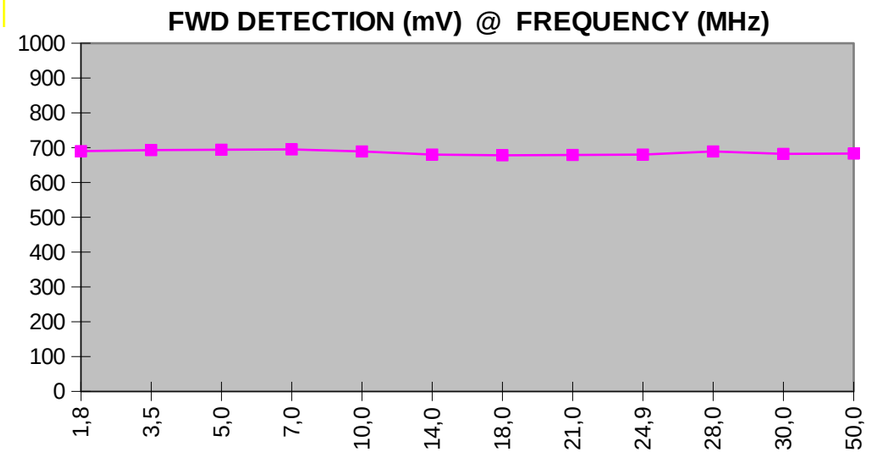
Auto SWR supply V > 9,7

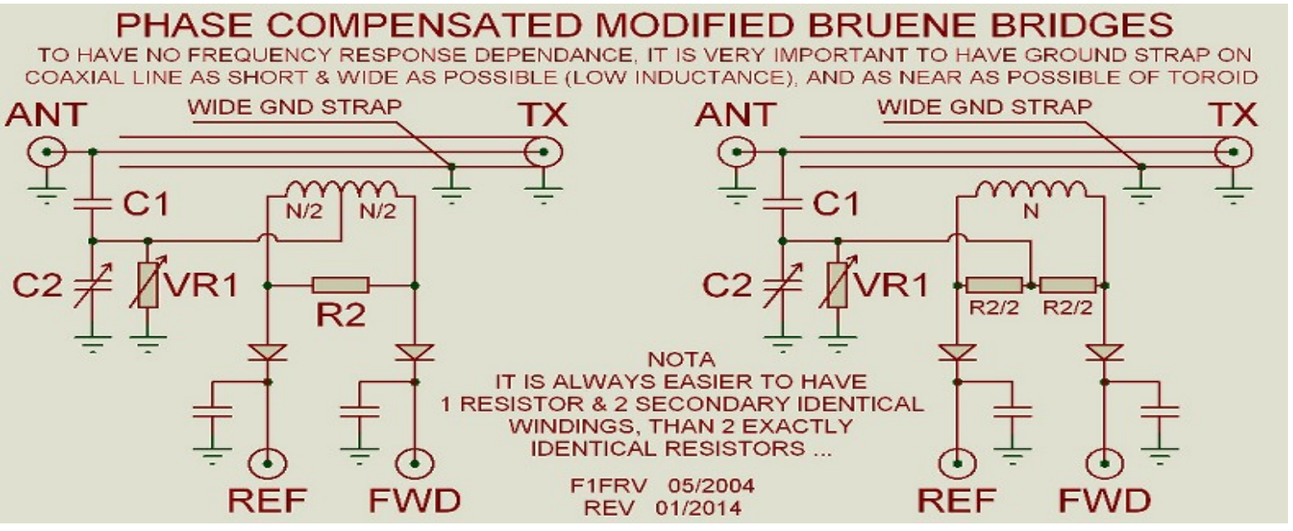
Nota: If necessary, install a resistive divider to reduce FWD & REF voltages outputs, for auto SWR lower supply voltage.

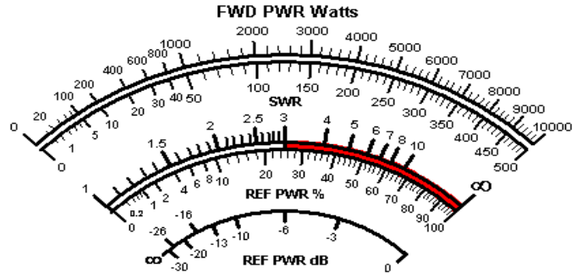
MEASUREMENT RESULTS WITH POWER 40 WATTS / 50 OHMS WITH VOLTMETER 10 MEGOHMS/V

ENTER YOUR MEASURED VALUES !!

FREQUENCY (MHz)	FWD VALUE		REF VALUE		
1,8	690	mV	0,10	mV	FT 5
3,5	693	mV	0,10	mV	FT 8
5,0	694	mV	0,10	mV	FT 11
7,0	695	mV	0,10	mV	FT 14
10,0	689	mV	0,10	mV	FT 24
14,0	680	mV	0,10	mV	FT 5
18,0	678	mV	0,10	mV	FT 8
21,0	679	mV	0,10	mV	FT 11
24,9	680	mV	0,10	mV	FT 14
28,0	689	mV	0,10	mV	FT 24
30,0	682	mV	0,10	mV	?
50,0	683	mV	0,10	mV	?
MEAN VALUE	686	mV	0,10	mV	?
MAXIMUM ERROR +/-	1,8	%			?







TOROIDS FLUX CALCULATIONS **CALCUL DU FLUX DANS LES TORES** **F1FRV January 2020 REVISION 13**

Results: Red on yellow **Résultats: Rouge sur fond jaune**

IF FLUX IS TOO HIGH, INCREASE NB OF SECONDARY TURNS !!!!
SI LE FLUX EST TROP IMPORTANT, AUGMENTER LE NB DE SPIRES SECONDAIRE !!!!

Toroids	Tores	FT 50-43	FT 82-43	FT 114-43	FT 140-43	FT 240-43	
1 toroid nominal specific inductance (Al)	Inductance specifique nominale (Al) d'un tore	480	470	510	885	1075	nH/Sp2
1 toroid Cross sectional area	Section d'un tore	0,133	0,246	0,375	0,806	1,61	Cm2
Maximum flux density for material 43	Flux maximum pour Materiau 43	2750	2750	2750	2750	2750	Gauss
Max flux to be used (20% of max flux)	Flux à ne pas depasser (20% du flux maxi)	**550**	**550**	**550**	**550**	**550**	**Gaus**
Flux density	**Flux**	**520**	**281**	**184**	**86**	**43**	**Gauss**

Toroids	Tores	FT 50-61	FT 82-61	FT 114-61	FT 140-61	FT 240-61	
1 toroid nominal specific inductance (Al)	Inductance specifique nominale (Al) d'un tore	69	75	80	140	170	nH/Sp2
1 toroid Cross sectional area	Section	0,133	0,246	0,375	0,806	1,61	Cm2
Maximum flux density for material 61	Flux maximum pour Materiau 61	2350	2350	2350	2350	2350	Gauss
Max flux to be used (20% of max flux)	Flux à ne pas depasser (20% du flux maxi)	**470**	**470**	**470**	**470**	**470**	**Gaus**
Flux density	**Flux**	**~~520~~**	**281**	**184**	**86**	**43**	**Gauss**

SWR Calculations by Ron Barker, G4JNH						
Enter Zo	**50,0**	**50,0**	**50,0**	**50,0**	**50,0**	**ohms**
Enter delivered power at wattmeter	**2500,0**	**2500,0**	**2500,0**	**2500,0**	**2500,0**	**watts**
Enter SWR	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	
Angle of reflection coefficient at wattmeter	**0,0**	**45,0**	**90,0**	**135,0**	**180,0**	**degrees**
Magnitude of reflection coefficient is	0,818	0,818	0,818	0,818	0,818	
Forward voltage is	614,9	614,9	614,9	614,9	614,9	volts (rms)
Forward current is	12,298	12,298	12,298	12,298	12,298	amps (rms)
Forward power is	**7562,5**	**7562,5**	**7562,5**	**7562,5**	**7562,5**	**watts**
Reflected voltage is	503,1	503,1	503,1	503,1	503,1	volts (rms)
Reflected current is	10,062	10,062	10,062	10,062	10,062	amps (rms)
Reflected power is	**5062,5**	**5062,5**	**5062,5**	**5062,5**	**5062,5**	**watts**
Line voltage at Wattmeter is	1118,0	1033,8	794,5	440,1	111,8	volts (rms)
Phase angle referenced to forward voltage is	0,000	0,351	0,686	0,941	0,000	radians
Percentage of reflected power	66,94215	66,94215	66,94215	66,94215	66,94215	%
Percentage of reflected voltage	81,81818	81,81818	81,81818	81,81818	81,81818	%
Line current at wattmeter is	2,236	8,803	15,890	20,676	22,361	amps (rms)
Phase angle referenced to forward current is	0,000	-0,941	-0,686	-0,351	0,000	radians
Coupling dB	**47,0927**	**47,0927**	**47,0927**	**47,0927**	**47,0927**	**dB**
Coupling ratio	**226,2742**	**226,2742**	**226,2742**	**226,2742**	**226,2742**	
Voltage derived from voltage sampler (Ev) is	4,941	4,569	3,511	1,945	0,494	volts (rms)
Voltage derived from current sampler (Ei) is	0,494	1,945	3,511	4,569	4,941	volts (rms)
Phase angle between Ev and Ei is	0,000	-1,293	-1,371	-1,293	0,000	radians
Vector sum of Ev and Ei is	5,435	5,435	5,435	5,435	5,435	volts (rms)
Vector difference between Ev and Ei is	4,447	4,447	4,447	4,447	4,447	volts (rms)
Rectified voltage presented to forward power meter is	7,686	7,686	7,686	7,686	7,686	volts DC
Rectified voltage presented to reflected power meter is	6,289	6,289	6,289	6,289	6,289	volts DC
Derived magnitude of reflection coefficient is	0,818	0,818	0,818	0,818	0,818	
Derived SWR is	10,00	10,00	10,00	10,00	10,00	
Ev/Ei ratio	10,00	2,35	1,00	0,43	0,10	

Power, DC voltages are at 1:10 VSWR	Estimated forward rectified voltage	Estimated reverse Dc voltage
10W	0,41	0,32
20W	0,61	0,48
30W	0,76	0,61
50W	1,01	0,81
70W	1,21	0,97
90W	1,384	1,119
110W	1,538	1,244
150W	1,808	1,466
200W	2,099	1,704
250W	2,356	1,914
300W	2,558	2,104
350W	2,801	2,278
400W	3	2,441
450W	3,186	2,593
500W	3,362	2,738
550W	3,53	2,875
600W	3,691	3,006
650W	3,844	3,132
700W	3,992	3,253
750W	4,135	3,37
800W	4,273	3,483
850W	4,407	3,592
900W	4,537	3,698
950W	4,663	3,802
1000W	4,786	3,902
1050W	4,906	4,001
1100W	5,023	4,096
1150W	5,138	4,19
1200W	5,25	4,282
1250W	5,36	4,372
1300W	5,467	4,46
1350W	5,573	4,546
1400W	5,677	4,631
1450W	5,778	4,714
1500W	5,879	4,796
1550W	5,977	4,877
1600W	6,074	4,956
1650W	6,169	5,034
1700W	6,263	5,111
1750W	6,355	5,186
1800W	6,447	5,261
1850W	6,537	5,335
1900W	6,625	5,407
1950W	6,713	5,479
2000W	6,799	5,55
2250W	7,216	5,891
2500W	7,611	6,213