



Generating A Part Number for a Dynacal® Permeation Device

Each Dynacal permeation device has its own specific part number. The easiest way to determine the part number for the particular device you need is to fill out a Fax Request Form and fax it to us. We'll promptly do the research and calculations described in this Technical Note and call you back with a part number, price, and delivery schedule. However, if you're the type that enjoys a challenge, follow the steps below to generate the part number for the specific device required by your application.

1. Check **Table 1** to see if the gas you require is among the most commonly ordered compounds. If it is not, call us for the information you need.
2. Determine the maximum concentration required, in ppm by volume. Designate this concentration "C".
3. Determine the minimum flow rate required, in cc/min. Designate this flow rate "F". (Hint: the minimum flow is dictated by the lowest available dilution flow setting and/or the sample flow that is needed for the analyzer or sensor.)
4. Calculate the required permeation rate (in ng/min) using the following formula:

$$P = \frac{FC}{K_m} \quad K_m = 24.46/MW$$

where P = permeation rate in ng/min, F = flow rate in cc/min, C = concentration in ppm, K_m = molar constant from column three of **Table 1**, MW = molecular weight of the permeant gas, and 24.46 is the molar volume in liters at 25°C and 760 mm Hg.

5. Refer to **Table 1** for the tabulated tubular permeation rates for the appropriate gas. Divide the required permeation rate (P in Step 4) by this tabulated permeation rate. The resulting quotient is the active length, in centimeters, of the tubular device required for your application.

Table 1

Gas	P/N	K _m	High E	Std. E	Low E	Low E #2	Temp(°C)
Acetaldehyde	2301	0.556	360	35			30
Acetic acid	2851	0.407	890	105			70
Acetone	2500	0.421	310	36			50
Acetonitrile	5301	0.596	365	50			50
Acrolein	2351	0.436	170	18			30
Acrylonitrile	5340	0.461	120	12			30
Ammonia	0140	1.439	*na	295		250	30
Benzaldehyde	2400	0.230	130	19			70
Benzene	1400	0.313	250	24			50
Bromine	0003	0.153	380	37			30
Butane-n	0503	0.421	420	15			30
Butyl mercaptan-n	6004	0.271	290				70
Butyl mercaptan-t	6007	0.271	75				70
Carbon disulfide	6300	0.321	700	62			30
Carbon tetrachloride	4203	0.159	200	14			50
Carbonyl sulfide	7600	0.407	*na	11000	WD(653)=280 9200		30
Chlorine	0002	0.346	*na	2100	915	1750	30
Chlorobenzene	4400	0.217	150				50
Chloroethane	4204	0.379	460	30			30
Chloroform	4202	0.205	640	60			50
Chloromethane	4200	0.484	4200	360			30
Cyclohexane	1003	0.291	570				90
Decane	0571	0.172	440				100
Dichloromethane	4201	0.288	420	35			30
Dimethyl acetamide N-N	5416	0.281	380	110			100
Dimethyl amine	5050	0.542	320	22			30
Dimethyl disulfide	6301	0.260	50	4			50
Dimethyl sulfide	6200	0.394	100	7			30
Ethanol	2001	0.531	1450				100
Ethyl acetate	3101	0.278	420	38			50
Ethyl benzene	1405	0.231	220				70
Ethyl mercaptan	6001	0.394	380	37			50
Ethylene oxide	3500	0.555	750	75			30
Formaldehyde	2300	0.815	520	140			100
Formic acid	2850	0.531	170	26			50
Freon - 11	4650	0.178	1950	68			30
Hexanal	2308	0.244	40				50
Hexane-n	0507	0.284	230	13			50

Table 1 (con't)

Gas	P/N	Km	High E	Std. E	Low E	Low E #2	Temp(°C)
Hydrochloric acid (20.2%)	0161	0.670	1490				100
Hydrogen cyanide	5300	0.905	360	48			30
Hydrogen fluoride	0040	1.224	*na	190	*na	170	30
Hydrogen sulfide	0110	0.719	*na	510		340	30
Iodine	0004	0.0964	370				100
Isopropyl alcohol	2003	0.407	420				90
Isopropyl benzene	1414	0.204	590				100
Isopropyl mercaptan	6003	0.321	340	40			70
Mercury	0030	0.122	355(SR)				100
Methanol	2000	0.764	190	30			50
Methyl acetate	3100	0.330	1090				50
Methyl amine	5000	0.788	620	65			30
Methyl bromide	4500	0.258	1450	134			30
Methyl ethyl ketone	2501	0.339	225	20			50
Methyl iodide	4600	0.172	890	60			50
Methyl isocyanate	7473	0.429	2000	210			30
Methyl mercaptan	6000	0.509	430	39			30
Methyl t-butyl ether	2810	0.277	250	23			70
Napthalene	1700	0.191	470				100
Nitric acid (68%)	0160	0.388	900				90
Nitrogen dioxide	0081	0.532	*na	1715	770	1450	30
Phenol	2250	0.260	270				100
Phosgene	7301	0.247	*na	670		570	30
Propane	0502	0.556	*na	70			30
Propyl mercaptan	6002	0.321	600	70			70
Propylene	0700	0.581	*na	230			30
Sulfur dioxide	0082	0.382	3700	410	215	340	30
Sulfur hexafluoride	0045	0.168	Wafer (553) = 370				30
Tetrachloroethylene	4304	0.147	360	30			50
Thiophane	6602	0.277	75				70
Toluene	1401	0.265	155	13			50
Toluene diisocyanate (2-4)	7480	0.140	60				70
Trichloroethylene	4303	0.186	1040	97			50
Water	0080	1.358	1950				100
Xylene-m	1403	0.230	1000				90
Xylene-o	1402	0.230	690				90
Xylene-p	1404	0.230	1380				90

*The permeation rates are either average values based on empirical data or calculations based on geometric considerations. Range or permeation rates: standard and low emission, $\pm 10\%$; high emission, $\pm 15\%$; wafer devices, $\pm 25\%$

If this quotient is:

Between 1.0 and 20.0

A single tubular device will meet your requirements.

Less than 1.0

Your application requires a wafer device. Proceed to Step 6 to continue the selection process. (Alternate: consult the Metronics Products Department to determine if a lower temperature can be used.)

Greater than 20.0

Your application requires more than one tubular device. Since active lengths are additive, specify several devices to yield a sum of individual active lengths which equals the required active length. (Alternate: consult the Metronics Products Department to determine if a higher temperature can be used.)

6. Refer to **Table 2**, which lists the ten most common wafer devices and the ratios of their permeation rates to the permeation rate for a standard emission tubular device. Choose and specify the device which has the ratio that most closely matches the quotient calculated in Step 5.

Table 2

Part Number	Wafer Device Type	Permeation Rate Ratio*
14X-534-XXXX	30T4 (.03" thick x 4/16" dia T wafer)	1.00
— 533 —	30T3 (.03" thick x 3/16" dia T wafer)	0.60
— 543 —	40T3 (.04" thick x 3/16" dia T wafer)	0.40
— 553 —	50T3 (.05" thick x 3/16" dia T wafer)	0.23
— 633 —	30F3 (.03" thick x 3/16" dia F wafer)	0.14
— 643 —	40F3 (.04" thick x 3/16" dia F wafer)	0.11
— 653 —	50F3 (.05" thick x 3/16" dia F wafer)	0.07
— 663 —	60F3 (.06" thick x 3/16" dia F wafer)	0.05
— 693 —	90F3 (.09" thick x 3/16" dia F wafer)	0.03
— 662 —	60F2 (.06" thick x 2/16" dia F wafer)	0.015

*The permeation rate ratio is the fraction of the standard emission rate that is obtained from the specified wafer device type. The ratios are either average values based on empirical data or calculations based on geometric considerations. The permeation rate ratio will give an estimated rate which is typically within $\pm 25\%$ of the actual value. Since the rate ratio varies significantly from one compound to another, we recommend certification for all wafer devices.

Converting All This Information Into a Dynacal Part Number

The grid below indicates the proper syntax for composing a permeation device part number. (All permeation device part numbers begin with "1".) Part numbers for any special device can be obtained directly from the Metronics Products Department.

Device Type

The second digit identifies the device type, as indicated. XLT devices are available in the same rate ranges as standard tubular devices.

1XX-XXX-XXXX-[XXXX]

Dynacal Permeation Device

Device Type

- 0 Tubular Device - High Emission
- 1 Tubular Device - Standard Emission
- 2 Tubular Device - Low Emission
- 3 Tubular Device - Special
- 4 Wafer Device
- 5 Wafer Device - Special
- 7 XLT Device - Standard Emission
- 8 XLT Device - Special

Certification

- 0 Uncertified
- 1 Tubular high range (> 500 ng/min)
- 2 Tubular mid range (101 - 500 ng/min)
- 3 Tubular low range (20 - 100 ng/min)
- 4 Wafer high range (> 100 ng/min)
- 5 Wafer low range (20 -100 ng/min)
- 6 Tubular or wafer ultra low range (5 - 19 ng/min)
- 7 Special temperatures, ranges, or accuracies

Permeation rate determining factor

- 002 to 200 Active tube length in mm
- 5 -- Wafer device with "T" wafer
- 6 -- Wafer device with "F" wafer
- 7 -- Wafer device with special wafer
- y - Wafer thickness (.0y")
- z Wafer diameter (z/16")

Permeant gas designation*

- 0001-0199 Inorganic compounds
- 0200-0499 Organo-metallic compounds
- 0500-1999 Hydrocarbons
- 2000-3999 Hydrocarbons containing oxygen
- 4000-4999 Hydrocarbons containing halogen
- 5000-5999 Hydrocarbons containing nitrogen
- 6000-6999 Hydrocarbons containing sulfur
- 7000-9999 Other organic compounds

[XXXX] Special configuration identities

Certification

The third digit identifies the level of certification. Any device that will be used in an application requiring precise knowledge of the gas concentration should be certified, meaning that it is shipped with documentation indicating the gravimetrically-determined permeation rate at some fixed temperature for that specific, individual device. We recommend certification for all wafer devices, due to their wider variation from the geometrically predicted permeation rates.

Permeation Rate Determining Factor

The next three digits of the part number specify the geometric factors which determine the permeation rate for each device. Note that the calculations in Step 5 yield an active length in centimeters, while the active length for tubular and XLT devices as specified in the part numbers is in millimeters (5 - 200 mm for tubular, 5 - 100 mm for XLT). **Table 2** lists only the ten most commonly ordered wafer devices, but we have numerous other geometries. For more details in this area, contact the Metronics Products Department.

Permeant Gas Designation

The last four digits identify the permeant gas contained in the device. Column two of **Table 1** lists the part number designation for the most commonly ordered gases. Call if you need information about other gases.

Examples

Calibration of an SO₂ source monitor

Conditions:

Mean SO₂ concentration at the source (C): 85 ppm (vol)

Monitor sampling rate (F): 660 cc/min

Monitor accuracy: ± 20%

Molar constant (K_m, from **Table 1**): .382

Inserting these values into the equation in Step 4 yields:

$$P = \frac{(660)(85)}{(.382)} = 146,859 \text{ ng/min}$$

Following the instructions in Step 5, we see in **Table 1** that the permeation rate for a high emission device is 3700. Dividing that into the value above gives the active length.

$$\frac{146,859}{3700} = 39.7 \text{ cm}$$

Since the active length quotient is more than 20 cm, the application requires multiple high emission SO₂ tubes with a combined active length approximating 39.7. Two 20 cm (200 mm) tubes would be a good choice, and the accuracy requirements do not demand certification. The part number for the required devices is 100 – 200 – 0082:

- 1 — Dynacal permeation device
 - 0 — High emission rate tubular device
 - 0 — Uncertified
-
- 2 } Active length in mm
 - 0 }
 - 0 }
-
- 0 } SO₂ designation
 - 0 }
 - 8 }
 - 2 }

Calibration of an ambient H₂S monitor

Conditions

- Max allowable concentration in the area being monitored (C): 0.5 ppm (vol)
- Monitor sampling rate (F): 175 cc/min
- Monitor accuracy: ± 5%
- Molar constant (K_m, from **Table 1**): .719

Inserting these values into the equation in Step 4 yields:

$$P = \frac{(175)(.5)}{(.719)} = 121.7 \text{ ng}_{\text{min}}$$

Following the instruction in Step 5, we see in **Table 1** that the permeation rate for a standard emission device is 510. Dividing that into the value above gives the active length for a standard emission device.

$$\frac{121.7}{510} = .239 \text{ cm}$$

Since the active length quotient is less than 1 cm, select the “best” wafer device from **Table 2**. (“Best” is the one having the Permeation Rate Ratio numerically closest to the active length calculated above.) For this example, the device designated as “553” is the

best fit (*i.e.*, its Permeation rate ratio is 0.23). The accuracy requirements of this application necessitate certification, so the part number for the required device is 144-553-0110.

- 1 — Dynacal permeation device
- 4 — Wafer device
- 4 — Wafer high range certification

5]
5] — Part number designator for specific wafer device type
3]

0]
1] — H₂S designation
1]
0]



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