KA8601C

SPEAKER PHONE WITH SPEECH NETWORK

INTRODUCTION

The KA8601C is a monolithic integrated circuit for use in high perfor-mance speaker phone system.

The KA860lC consists of speaker phone and speech network. Speaker phone includes attenuators, amplifiers, level detectors, attenuator control, hybrid amplifiers, regulator and AGC circuit. Speech network includes transmit amp, receive amp, voltage regulator for dialer, side tone control, and line equalizer.

FEATURES

- Speaker Phone
  - Low Operating Voltage (3.0 ~ 6.5V)
  - High Attenuator Gain Range (52dB)
  - Improved Sensitivity (Four-point Signal Sensing)
  - Chip Disable for Active or Standby Operation
  - Microphone Amp Gain set by External Components
- Speech Network
  - Low Operating Voltage (1.5V : speech)
  - Regulated Voltage for Dialer (Typically 3.3V)
  - Transmit, Receive, Side Tone Gains set by External Components
  - Mute Input for DTMF Dialing
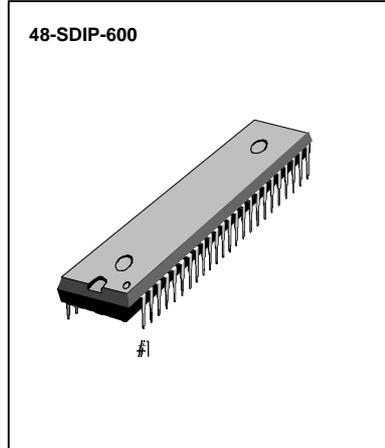
48-SDIP-600

ORDERING INFORMATION

Device	Package	Operating Temperature
KA8601C	48-SDIP-600	- 25°C ~ + 75°C

BLOCK DIAGRAM

KA8601C   SPEAKER PHONE WITH SPEECH NETWORK

PIN CONFIGURATION

```
                      DTO+  1        48  DTO-
                        CD  2        47  DTI
                        FI  3        46  RXO_ATT
                        FO  4        45  RXI_ATT
                        R̄4  5        44  GND
                       V_I  6        43  PD_RX
                       V_L  7        42  DETI_RX1
                       L_C  8        41  DETO_RX1
                       V_R  9        40  DETO_TX1
                     MICI- 10        39  DETI_TX1
                     MICI+ 11  KA8601C  38  MICO
                       GND 12        37  MICI
                      MICO 13        36  MT
                       TXI 14        35  V_C
                       AGC 15        34  C_T
                      RXO+ 16        33  DETI_RX2
                        NC 17        32  DETO_RX2
                        NC 18        31  DETO_TX2
                      RXO- 19        30  DETI_TX2
                       RXI 20        29  PD_TX
                    RXO_SUM 21       28  V_B
                       Z_B 22        27  TXI_ATT
                        MS 23        26  TXO_ATT
                      V_CC 24        25  V_DD
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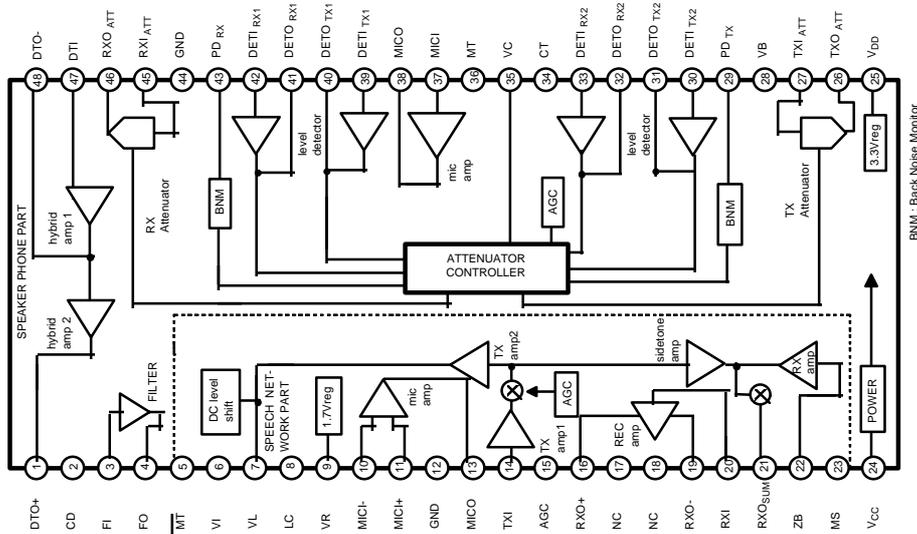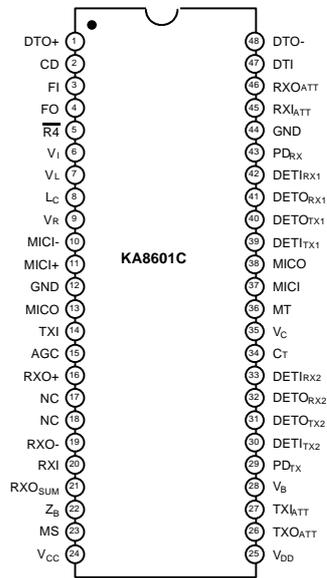
Fig. 2

PIN DESCRIPTION

Pin No	Symbol	Description
1	DTO+	Output of the second hybrid amplifier.
2	CD	Chip Disable. A logic low (<0.8V) sets normal operation.
3	FI	Filter input.
4	FO	Filter output.
5	$\overline{MT}$	Mute input. A logic "1" sets normal speech mode.
6	V_I	A resistor connected from this pin to V_{SS} sets the AC terminating impedance.
7	V_L	Power supply for the speech network. Supply voltage is derived from loop current. T_X amp output operates on this pin.
8	L_C	Resistor at this pin set the DC characteristics of the circuit.
9	V_R	A 1.7 volt regulated output which can be used to bias the mic.
10	MICI-	Inverting differential input to the mic amp.
11	MICI+	Non-inverting differential input to the mic amp.
12	GND	Ground pin for the speech network.
13	MICO	Mic amp output.
14	TXI	Input to the T_X amp from the Mic amp.
15	AGC	Loop current sensing input.

PIN DESCRIPTION (continued)

Pin No	Symbol	Description
16	RXO+	R_X amp non-inverting differential output.
17	NC	No connection.
18	NC	No connection.
19	RXO-	R_X amp inverting differential output.
20	RXI	Input to the R_X amp.
21	RXO_{SUM}	Summed output of the R_X current amp.
22	Z_B	Input to the R_X current amp.
23	MS	Mode select input. A logic "1" $\rightarrow$ pulse dialing, A logic "0" $\rightarrow$ tone (DTMF) dialing.
24	V_{CC}	A supply voltage pin for the speaker phone part.
25	V_{DD}	A regulated 3.3 volt output for an external dialer.
26	TXO_{ATT}	Output of the T_X attenuator.
27	TXI_{ATT}	Input to the T_X attenuator.
28	V_B	This voltage is a system AC ground, and biases the volume control. A filter cap is required.
29	PD_{TX}	An RC at this pin sets the time constant for the T_X background monitor.
30	$DETI_{TX}2$	Input to the T_X level detector on the mike/speaker side.
31	$DETO_{TX}2$	Output of the T_X level detector on the mike/speaker side.
32	$DETO_{RX}2$	Output of the R_X level detector on the mike/speaker side.
33	$DETI_{RX}2$	Input to the R_X level detector on the mike/speaker side.
34	C_T	This pin sets the response time for the circuit to switch modes.
35	V_C	Volumn control input.
36	MT	Mute input. A logic low (<0.8V) sets normal operation. A logic high (>2.0V) mutes the mic amp.
37	MICI	Input and summing node of the mic amp.
38	MICO	Output of the mic amp is set by external resistors.
39	$DET_{TX}1$	Input to the T_X level detector on the line side.
40	$DETO_{TX}1$	Output of the T_X level detector on the line side.
41	$DETO_{RX}1$	Output of the R_X level detector on the line side.
42	$DETI_{RX}1$	Input to the R_X level detector on the line side.
43	PD_{RX}	A RC at this pin sets the time constant for the R_X background monitor.
44	GND	Ground pin for the speaker phone part.
45	RXI_{ATT}	Input to the R_X attenuator and dial tone detector.
46	RXO_{ATT}	Output of the R_X attenuator.
47	DTI	Input and summing node of the mic amp.
48	DTO -	Output of the first hybrid amplifier.

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ABSOLUTE MAXIMUM RATINGS

Characteristic		Symbol	Value	Unit
Speaker Phone	Supply Voltage	V_{CC}	- 1.0 ~ + 7.0	V
	Voltage at V_C	$V_{I\,(VC)}$	- 1.0 ~ V_{CC} + 0.5	V
	Voltage at CD,MT	$V_{I\,(CM)}$	-1.0 ~ V_{CC} + 1.0	V
	Voltage at T_XI, R_XI, HFI	$V_{I\,(TRH)}$	- 0.5 ~ V_{CC} + 0.5	V
Speech Network	Supply Voltage	V_{CC}	- 1.0 ~ + 12	V
	Supply Voltage for dialer	V_{DD}	- 1.0 ~ + 6.0	V
	Voltage at MT_S, MS	$V_{I\,(MS)}$	- 1.0 ~ V_{DD} + 0.5	V
	Current Through V_L, L_C	$I_{I\,(VL,\,LC)}$	130	mA
	Current into Z_B	$I_{I\,(ZB)}$	3	mA
Operating Temperature		T_{OPR}	- 25 ~ + 75	°C
Storage Temperature		T_{STG}	- 65 ~ + 150	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

Characteristic	Symbol	Test Conditions		Min	Typ	Max	Unit
SPEECH NETWORK (Ta = 25°C, unless otherwise noted)							
Line Voltage	V_L	Speech Mode	I_L = 30mA	3.0	3.9	4.7	V
		Pulse Mode	I_L = 120mA	8	9.8	11.5	
		Tone Mode	I_L = 30mA	4.4	5.1	6.5	
V_R Voltage	V_R	I_L = 30mA	Speech Mode	1.55	1.7	1.85	V
MF Operating Voltage	$V_{DD\,(MF)}$	V_L = 4.5V	Tone Mode	3.0	3.3	3.8	V
		Tone Mode	I_{DD} = 1.6mA	3.0	3.3	3.8	
MF Operating Current (Max)	$I_{DD\,MF\,(MAX)}$	I_L = 30mA	Speech Mode	0.5	1.1	2.0	mA
			Pulse Mode	2	2.8	4	
			Tone Mode	2	2.8	4	
MICO Bias Voltage	$V_{BIAS\,(MPO)}$	I_L = 30mA	Speech Mode	0.8	1.08	1.4	V
TXI Bias Voltage	$V_{BIAS\,(TxTs)}$	I_L = 30mA	Speech Mode	0.04	0.086	0.2	V
MIC Amp Gain	$G_{V\,(MIC)}$	I_L = 30mA	Speech Mode	27	30	33	dB
MIC Common Mode Rejection Ratio	$CMRR_{(MIC)}$	-		30	64	-	dB
MIC Gain Reduction	$\Delta G_{V\,(MIC)}$	$\overline{MT}$ = 0V		-10	-60	-	dB
T_X Gain	$G_{V\,(TX)}$	Speech Mode	I_L = 30mA	30	34.8	60	dB
			I_L = 80mA	28	31	34	
T_X Distortion	THD_{TX}	I_L = 30mA	Speech Mode	-	-	2	%
R_X Gain	$G_{V\,(RX)}$	Speech Mode	I_L = 30mA	-15	-10.5	-2	dB
			I_L = 80mA	-17	-14	-10	
R_X Distortion	THD_{RX}	I_L = 30mA	Speech Mode	-	-	2	%
Side Tone Gain	$G_{V\,(ST)}$	I_L = 30mA	Speech Mode	-	10	15	dB

ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Test Condition		Min	Typ	Max	Unit
Side Tone Rejection	RST			20	25	-	dB
MUTE Input Impedance	$Z_{I\,(MUTE)}$			-	60	-	KΩ
MUTE Input Low Voltage	$V_{IL\,(MUTE)}$			-		1.0	
MUTE Input High Voltage	$V_{IH\,(MUTE)}$			V_{DD} -0.3		-	V
MS Input Low Voltage	$V_{IL\,(MS)}$			-		0.8	
MS Input High Voltage	$V_{IH\,(MS)}$			2.0		-	
L_C Level Shift	ΔV_{LC}	$I_L = 30mA$	Speech Mode	2.1	2.9	3.5	V
			Pulse Mode	2.1	2.9	3.5	
			Tone Mode	3.4	4.3	5.2	

SPEAKER PHONE (Ta = 25°C, V_{CC} = 5.0V, unless otherwise noted)

Characteristic	Symbol	Test Condition		Min	Typ	Max	Unit
Operating Current	I_{CC}	$V_{CC} = 6.5V$	CD = 0.8V	-	5.5	8.0	mA
			CD = 2V	-	0.6	0.8	
Reference Voltage	V_{REF}			1.8	2.1	2.4	V
			$I_L = 1.0mA$	1.5	1.7	1.9	
		$V_{CC} = 3.5V$		-	1.3	-	
R_X Attenuator Gain	$G_{ATT\,(RX)}$	$V_C = V_B$		4.0	6.0	8.0	dB
		$V_{CC} = 3.5V, V_C = V_B$		4.0	6.0	8.0	
		$V_{CC} = 2.8V, V_C = V_B$		-	-19	-11	
R_X Attenuator Gain Change	$\Delta G_{ATT\,(RX)}$	$V_{CC} = 3.5V$, to 5.0V		-0.5	0	+0.5	dB
R_X Attenuator AGC Gain Change	$\Delta G_{ATT\,AGC\,(RX)}$	$V_{CC} = 2.8V$, to 5.0V		-	-25	-15	dB
R_X Attenuator Gain (Idle Mode)	$G_{ATT\,RX\,(IM)}$	$V_C = V_B$		-22	-20	-17	dB
R_X Attenuator Gain Range	$G_{ATT\,(RX)}$	$V_C = V_B$ (R_X to T_X Mode)		49	52	54	dB
R_X Volume Control Range	$G_{V\,CTL\,(RX)}$	$V_C = 0.1V_B$		27	35	-	dB
R_X DC Output Voltage	$V_{O\,(RX)}$			-	V_B	-	V
R_X DC Output Voltage Change	$\Delta V_{O\,(RX)}$	R_X to T_X Mode		-	± 10	±150	mV
R_X DC Output High Voltage	$V_{OH\,(RX)}$	$V_{RXI} = 3.5V$		3.7	-	-	V
R_X DC Output Low Voltage (with respect to V_B)	$V_{OL\,(RX)}$	$V_{RXI} = 1V$		-	-1.5	-1.0	V
R_X Mode Distortion	THD_{RX}			-	0.5	3	%
C_T Voltage (with respect to V_B)	V_{CT}	R_X Mode		-	+240	-	mV
		Idle Mode		-	0	-	
		T_X Mode		-	-240	-	
Dial Tone Detector Threshold	$V_{TH\,(DET)}$	$V_C = V_B, V_{RXI} = 3.0V$		10	15	20	mV
T_X Attenuator Gain	$G_{ATT\,(TX)}$			4.0	6.0	8.0	dB
T_X Attenuator Gain Range	$G_{ATT\,(TX)}$			49	52	54	dB
T_X Output DC Voltage	$V_{O\,(TX)}$			-	V_B	-	V
T_X Output DC Voltage Change	$\Delta V_{O\,(TX)}$			-	± 30	±150	mV

ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
T_X Output High Voltage	$V_{OH\,(TX)}$	$V_{TXI} = 3.5V$	3.7	-	-	V
T_X Output Low Voltage	$V_{OL\,(TX)}$	$V_{TXI} = 1.0V$	-	0.5	1	V
T_X Mode Distortion	THD_{TX}		-	0.8	3	%
MIC Voltage Gain	$G_{V\,(MIC)}$		70	80	-	dB
MIC Output Offset Voltage	$V_{OO\,(MIC)}$		-50	0	+50	mV
MIC Output High Voltage	$V_{OH\,(MIC)}$	$V_{MIC} = 1.0V$	3.7	-	-	V
MIC Output Low Voltage	$V_{OL\,(MIC)}$	$V_{MIC} = 3.0V$	-	-	200	mV
MIC Input Bias Current	$I_{BIAS\,(MIC)}$		-	-40	-	nA
Muting (Gain)	$G_{V\,(MUTE)}$	$V_{MT} = 2V, f = 1KHz$	-55	-	-	dB
MIC Amp Distortion	THD_{MIC}		-	0.15	-	%
MUTE Input High Voltage	$V_{IH\,(MUTE)}$	$0.3KHz \le f \le 10KHz$	2.0	-	V_{CC}	V
MUTE Input Low Voltage	$V_{IL\,(MUTE)}$		0	-	0.8	V
Open Loop Gain (Hybrid Amp)	$G_{V\,(HA)}$		60	80	-	dB
DTO-Output High Voltage	$V_{OH\,(DTO-)}$		3.7	-	-	V
DTO-Output Low Voltage	$V_{OL\,(DTO-)}$		-	-	250	mV
DTO+Output High Voltage	$V_{OH\,(DTO+)}$	$I_O = -5mA$	3.7	-	-	V
DTO+Output Low Voltage	$V_{OL\,(DTO+)}$	$I_O = 5mA$	-	-	250	mV
DTO Distortion	THD_{DTO}	$I_O = -5mA$	-	0.3	-	%
Filter Offset Voltage	$V_{IO\,(F)}$	$I_O = 5mA$	-22	-90	0	mV
Filter Input Bias Current	$V_{BIAS\,(F)}$		0	-50	-	mA

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APPLICATION INFORMATION
FUNCTION DESCRIPTION

SPEECH NETWORK

1. MICROPHONE AMPLIFIER
This microphone amplifier is equipped with a fixed gain (30dB). Its basic configuration is shown in figure 3.
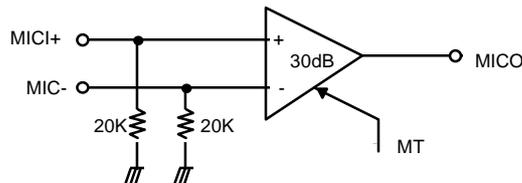
Fig .3

This amplifier has a mute function. If a mute signal from the dialer is inputted when the speech network is in the mute mode, the microphone amplifier will be muted.

2. VOLTAGE REGULATOR (DIALER INTERFERENCE)
This voltage regulator has a minimum output voltage of 3.1 volts. When the dialer is not in motion, its minimum current is 1.0mA, where as when the dialer is moving the minimum current is 2.2mA.

3. VOLTAGE REFERENCE
Generally when in the voltage reference mode, the microphone's bias voltage is used, but when in the TXI_{ATT} mode, DC bias voltage is used. The output voltage of the voltage reference is a minimum of 1.6 volts.

SPEAKER PHONE

1. MICROPHONE AMPLIFIER
This device amplifies outside microphone signals, which are inputted while in the inverting mode. As it alters elements, the microphone amplifier allows for them to be modulated. Its open loop gain is 80dB, while the band width is typically 1.0KHz. It has a mute function, and when operating in the mute mode at least 2.0V, the microphone amplifier gain is reduced to around 40dB. If the mute mode is not used, it must connected with the ground.


Bias Voltage
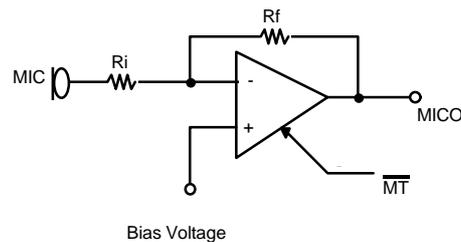
Fig. 4

2. VOLUME CONTROL

The volume control can only be applied in the receive mode. If the voltage of the V_C mode is the same as the V_B, the receive attenuator gain is maximized and the transmit gain is minimized. At the same time, if the V_C mode voltage is less than the V_B, the receive attenuator gain is reduced.
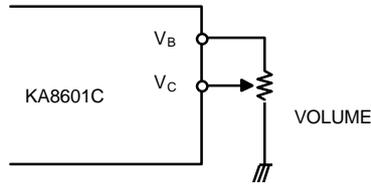
Fig. 5

3. VOICE DETECTION FUNCTION

The voice detection function compares the microphone amplifier output level with the outside audio amplifier level and the transmit attenuator output level with the receive attenuator input level, after which they are inputted into the control box. The block diagram of the voice detection function is as follows:
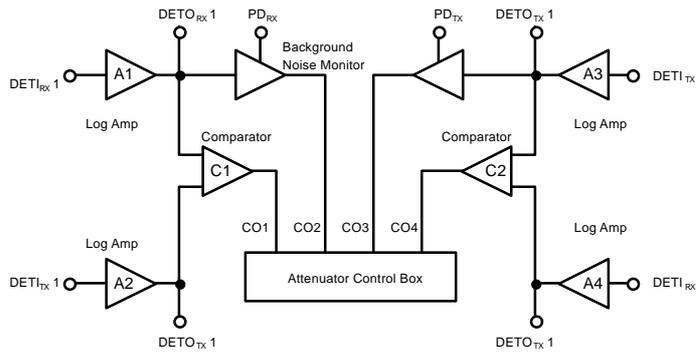
Fig. 6

It is useful to use a background noise monitor when high background noise occurs. When the input signals to the background noise monitor are increased, voltage for the PD_{RX} (PD_{TX}) mode is stably increased. The increase time is determined by 100KΩ and 47μF.

4. ATTENUATOR CONTROL BOX

In figure 6, each signal coming into the log amplifier is amplified and then inputted into the comparator (C1, C2). The comparator compares the amplified signal levels, after which they are inputted into the attenuator control box. The attenuator control box processes these signals (CO1, CO2, CO3, CO4) as logic signals, and which are put into one of the following modes:

1. Receive Mode
2. Transmit Mode
3. Slow Idle Mode
4. Fast Idle Mode
Which of the above modes is to be determined depending on the following conditions:

1) Receive Mode

$DETO_{TX}1 < DETO_{RX}1$, $DETO_{TX}2 < DETO_{RX}2$, PD_{TX}, X, PD_{RX} : 1

2) Transmit Mode

$DETO_{TX}1 > DETO_{RX}1$, $DETO_{TX}2 > DETO_{RX}2$, PD_{TX} : 1, PD_{RX} : X

3) Slow Idle Mode

$DETO_{TX}1 > DETO_{RX}1$, $DETO_{TX}2 > DETO_{RX}2$, PD_{TX} : 0, PD_{RX} : X
$DETO_{TX}1 < DETO_{RX}1$, $DETO_{TX}2 < DETO_{RX}2$, PD_{TX} : 0, PD_{RX} : X
$DETO_{TX}1 < DETO_{RX}1$, $DETO_{TX}2 > DETO_{RX}2$, PD_{TX} : 0, PD_{RX} : X
$DETO_{TX}1 > DETO_{RX}1$, $DETO_{TX}2 < DETO_{RX}2$, PD_{TX} : 0, PD_{RX} : X

4) Fast Idle Mode

$DETO_{TX}1 > DETO_{RX}1$, $DETO_{TX}2 < DETO_{RX}2$, PD_{TX} : 0, PD_{RX} : 0
$DETO_{TX}1 < DETO_{RX}1$, $DETO_{TX}2 > DETO_{RX}2$, PD_{TX} : Y, PD_{RX} : Y
* "<" and ">" refer to voltage level : "X" refers to "It doesn't matter : "Y" is not zero

5. SWITCHING TIME

The switching time of the speaker phone is determined by the C_T and R_T of the outside elements.
1. Idle Mode $\rightarrow$ R_X or T_X Mode
   ST = 4,000 X C_T
2. T_X or R_X Mode $\rightarrow$ Fast Idle Mode
   ST = 2,000 X C_T
3. T_X or R_X Mode $\rightarrow$ Slow Idle Mode
   ST = R_T X C_T
* C_T, R_T refer to the capacitor and resistor between Pin 34 and V_{CC}.

APPLICATION CIRCUIT

48-SDIP-600

Dimensions in Milimeters/inches

13.80 ±0.20
0.543 ±0.008

#1   #48

#24   #25

15.24
0.600

0° ~ 15°

0.25 +0.10 -0.05
0.010 +0.004 -0.002

0.79
0.031

0.46 ±0.10
0.018 ±0.004

0.89 ±0.10
0.035 ±0.004

1.778
0.070

42.87 MAX
1.688

42.47 ±0.20
1.672 ±0.008

3.85 ±0.20
0.152 ±0.008

0.38 MIN
0.015

5.08 MAX
0.200

3.30 ±0.30
0.130 ±0.012

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